MODEL

IB-1100 Frequency Counter

HEATHKIT®

ASSEMBLY MANUAL

HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATHKIT®

Copyright © 1972
Heath Company
All rights reserved

PRICE $2.00

595-1491-03

Dear Customer:

The Heathkit electronic product you have purchased is one of the best performing electronic products in the world.

Here's how we aim to keep it that way:

Your Heathkit Warranty

During your first 90 days of ownership, any parts which we find are defective, either in materials or workmanship, will be replaced or repaired free of charge. And we'll pay shipping charges to get those parts to you — anywhere in the world.

If we determine a defective part has caused your Heathkit electronic product to need other repair, through no fault of yours, we will service it free — at the factory, at any retail Heathkit Electronic Center, or through any of our authorized overseas distributors.

This protection is exclusively yours as the original purchaser. Naturally, it doesn't cover damage by use of acid-core solder, incorrect assembly, misuse, fire, flood or acts of God. But, it does insure the performance of your Heathkit electronic product anywhere in the world — for most any other reason.

After-Warranty Service

What happens after warranty? We won't let you down. If your Heathkit electronic product needs repairs or you need a part, just write or call the factory, your nearest retail Heathkit Electronic Center, or any Heath authorized overseas distributor. We maintain an inventory of replacement parts for each Heathkit model at most locations — even for many models that no longer appear in our current product line-up. Repair service and technical consultation are available through all locations.

We hope you'll never need our repair or replacement services, but it's nice to know you're protected anyway — and that cheerful help is nearby.

Sincerely,

HEATH COMPANY
Benton Harbor, Michigan 49022

Prices and specifications subject to change without notice.

Assembly and Operation of the

HEATHKIT

FREQUENCY COUNTER MODEL IB-1100

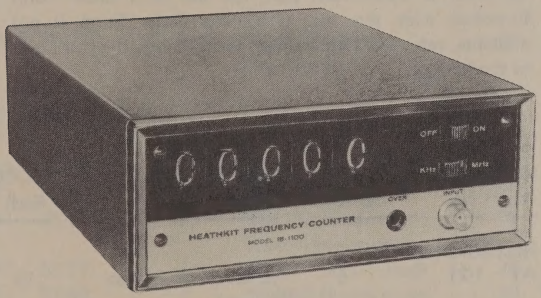


TABLE OF CONTENTS

Introduction 2
Parts List 2
Step-by-Step Assembly 5
Circuit Board Assembly 6
Chassis Assembly
- Chassis Parts Mounting 18
- Circuit Board Mounting 20
- Transformer Primary Wiring 24
- Panel and Label Mounting. 26
- Test Cable Assembly 27

Initial Checkout 28

Final Assembly 30

Calibration 31

Operation 35

In Case of Difficulty 36
- Troubleshooting Chart 38

Specifications 41

Circuit Description 42

Circuit Board X-Ray Views 46

Circuit Board Voltage Charts 48

Chassis Photograph 50

Tube-Transistor Identification Chart 51

Diode Identification Chart 52

Integrated Circuit Base Diagrams 53

Circuit Board Functional Areas 54

Schematic. . .(fold-out from page) 55

Warranty . . . . . Inside front cover

Customer Service . . . . . Inside rear cover

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022
a Schlumberger company

INTRODUCTION

The Heathkit Model IB-1100 Frequency Counter is a compact, lightweight, easy-to-use, solid-state frequency counter which is capable of accurate measurements from 1 Hz to over 30 MHz. One of the many features that make it so convenient and easy to operate is the simple, straight-forward design of the front panel. A power switch and a MHz/kHz time base switch are the only controls. The input attenuator required in some counters has been eliminated by an especially designed input protection circuit which assures minimum loading to the circuit under test. Five display tubes provide a bright readout at a glance and a neon lamp is used as an overrange indicator.

Excellent accuracy is assured by a modern, digital design and a specially selected crystal for control of the time base oscillator. This crystal-controlled "clock" approaches the performance characteristics of a temperature-compensated crystal oscillator.

Additional features include the rugged and compact cabinet design, the detachable test cable, and front feet equipped with snap-down wire bails so the front panel may be elevated for a different viewing angle.

Exceptional accuracy, compact design, and the simplified operating controls combine to make this Counter an invaluable tool for the engineer, technician, or hobbyist.

Refer to the "Kit Builders Guide" for information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

PARTS LIST

Check each part against the following list. The key numbers correspond to the numbers on the Parts Pictorial (fold-out from Page 5). Any part that is packaged in an individual envelope with a part number on it should be placed back in its envelope after it is identified until it is called for in a step.

To order a replacement part, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of the Manual.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
RESISTORS				
1/2-Watt, 10%				
A1	1-1	1	47 Ω (yellow-violet-black)	.15
A1	1-2	1	68 Ω (blue-gray-black)	.15
A1	1-3	2	100 Ω (brown-black-brown)	.15
A1	1-66	2	150 Ω (brown-green-brown)	.15
A1	1-45	2	220 Ω (red-red-brown)	.15
A1	1-42	3	270 Ω (red-violet-brown)	.15
A1	1-48	2	390 Ω (orange-white-brown)	.15
A1	1-7	2	680 Ω (blue-gray-brown)	.15
A1	1-9	7	1000 Ω (brown-black-red)	.15
A1	1-93	1	1800 Ω (brown-gray-red)	.15
Resistors (cont'd.)				
A1	1-21	5	15 kΩ (brown-green-orange)	.15
A1	1-23	1	27 kΩ (red-violet-orange)	.15
A1	1-26	3	100 kΩ (brown-black-yellow)	.15
A1	1-35	1	1 MΩ (brown-black-green)	.15
Other Resistors-Controls				
A2	2-227	1	550 Ω, 1/2-watt, 1% resistor	1.00
A2	2-194	1	794 Ω, 1/2-watt, 1% resistor	1.00
A3	10-381	1	500 Ω, 2-watt control	1.00
A3	10-387	1	3000 Ω, 2-watt control	1.00
A4	10-918	1	500 Ω, 2-watt control	1.00

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
CAPACITORS				
Disc				
A5	21-3	2	10 pF	.15
A5	21-171	1	680 pF	.15
A5	21-27	1	.005 μF	.15
A6	21-16	4	.01 μF	.15
Electrolytic				
A7	25-54	2	10 μf	.30
A8	25-257	1	10 μF (upright)	.40
A9	25-117	1	100 μF	.75
A10	25-104	1	200 μF	1.30
A11	25-230	1	2000 μF	2.85
Other Capacitors				
A12	31-64	1	1-30 pF piston trimmer	4.45
A13	20-76	1	68 pF mica	.25
A14	27-61	1	0.47 μF metalized film	.60
A15	25-220	1	10 μF electrolytic (tantalum)	.70
DIODES-TUBES				
B1	56-63	1	Zener diode, 5.6V	1.35
B1	56-36	1	Zener diode, 16.1V	2.25
B1	56-56	2	1N4149 silicon diode (yellow-brown-yellow-white)	.30
B1	57-27	1	1N2071 silicon diode	.75
B1	57-65	4	1N4002 silicon diode	.30
B2	411-284	5	Display tubes ZM1000	5.40
B3	412-15	1	NE2H neon lamp	.30

TRANSISTORS

NOTE: The following transistors and integrated circuits are marked for identification in one of the following four ways. (The term "type number" refers to the numbers in a transistor or integrated circuit description, together with any letters between numbers, for example, 74HI02 2N3393. It does not refer to the prefix or suffix letters, which could change.)

1. Part number.
2. Transistor or integrated circuit type number.
3. Part number and type number.
4. Part number with a type other than the one listed.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
Transistors (cont'd.)				
C1	417-118	2	2N3393	.40
C2	417-125	2	2N3563	.60
C3	417-134	1	MPS6520	1.05
C4	417-154	1	2N2369	1.65
C5	417-173	1	ETS083	.50
C6	417-175	1	2N5294	1.45
C7	417-235	1	2N4121	.60
C8	417-251	1	SFC2912 JFET	3.00
C9	417-260	2	2N4258A	.95
C10	417-269	1	SGC5282	1.00
INTEGRATED CIRCUITS				
D1	443-1	3	SN7400N	.70
D1	443-4	1	SN7472N	1.35
D1	443-5	1	SN7473N	.95
D1	443-7	10	SN7490N	2.95
D1	443-43	1	SN74H102N	2.65
D2	443-35	5	N7441B	4.30
D2	443-13	5	SN7475N	2.95
D2	443-16	1	SN7476N	1.35
SWITCHES-CONNECTOR-SOCKETS				
D3	60-70	1	SPST slide switch	.40
D4	60-71	1	DPDT slide switch	.50
D5	432-758	1	BNC connector	1.65
D6	434-225	16	14-pin dual-in-line socket	.25
D7	434-226	11	16-pin dual-in-line socket	.25
D8	434-234	5	Display tube socket	1.05
HARDWARE				
#3 Hardware				
E1	250-1149	4	3-48 x 7/16" black screw	.05
E2	252-1	4	3-48 nut	.05
E3	254-7	4	#3 lockwasher	.05
#4 Hardware				
E4	250-273	1	4-40 x 3/8" screw	.05
E5	252-15	1	4-40 nut	.05

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
#6 Hardware				
F1	250-116	11	6-32 x 1/4" black screw	.05
F2	250-587	5	6-32 x 5/16" screw	.05
F3	250-89	2	6-32 x 3/8" screw	.05
F4	250-357	1	6-32 x 3/8" black nylon screw	.05
F5	250-8	7	#6 x 3/8" sheet metal screw	.05
F6	250-162	6	6-32 x 1/2" screw	.05
F7	252-3	9	6-32 nut	.05
F8	254-1	9	#6 lockwasher, internal tooth	.05
F9	254-6	12	#6 lockwasher, external tooth	.05
F10	253-2	2	#6 fiber shoulder washer	.05
F11	259-1	2	#6 solder lug	.05
#8 Hardware				
G1	250-137	2	8-32 x 3/8" screw	.05
G2	252-4	2	8-32 nut	.05
G3	254-2	4	#8 lockwasher	.05
Miscellaneous Hardware				
G4	255-103	6	6-32 x 5/16" spacer	.10
G5	252-7	1	Control nut	.05
G6	259-10	1	Control solder lug	.05
G7	260-16	2	Alligator clip	.10
G8	266-846	2	Wire bail	.75
INSULATORS-GASKETS-COMPOSITION ITEMS				
H1	73-34	2	Clip insulators	.15
H2	73-39	1	Foam rubber	.15/ft
H3	75-52	1	Switch insulator	.15
H4	75-71	1	Strain relief	.15
H5	75-704	1	Transistor insulator	.15
H6	261-16	1	1/2" round foot	.05
H7	261-36	2	3/4" round foot	.15
H8	261-35	2	1" round foot	.20

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
CABLE-WIRE				
	89-23	1	Line cord	1.25
	134-237	1	Cable assembly	3.30
	340-11	1	#12 bare wire	.10/ft
	344-50	1	Black wire	.05/ft
	344-51	1	Brown wire	.05/ft
	344-3	1	Red wire	.05/ft
	344-53	1	Orange wire	.05/ft
	344-55	1	Green wire	.05/ft
	344-56	1	Blue wire	.05/ft
	344-57	1	Violet wire	.05/ft
	344-58	1	Gray wire	.05/ft
	344-59	1	White wire	.05/ft
CHASSIS-CABINET PARTS				
J1	90-588-1	1	Cabinet shell	5.95
J2	200-647-1	1	Chassis	3.65
J3	203-1452	1	Front panel	4.15
J4	210-58	1	Bezel	3.40
MISCELLANEOUS				
	54-816	1	Power transformer	7.50
	85-1231-1	1	Printed circuit board	17.20
K1	352-13	1	Silicone grease	.25
	391-34	1	Blue and white identification label	
K2	404-414	1	1 MHz crystal	15.05
K3	421-33	1	1/4-ampere, 3AG, slow-blow fuse	.50
K4	422-1	1	Fuse block	.40
K5	490-5	1	Nut starter	.15
K6	490-111	1	Integrated circuit puller	.15
K7	490-109	1	White alignment tool	.15
	390-362	1	Fuse replacement label	.15
	597-260	1	Parts Order Form	
	597-308	1	Kit Builders Guide	
		1	Manual (See front cover for part number.)	2.00
			Solder (Additional 3' rolls of solder, #331-6, can be ordered for 25 cents each.)	

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage, and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

STEP-BY-STEP ASSEMBLY

Before starting to assemble this kit, read the "Kit Builders Guide" for complete information on wiring, soldering, and step-by-step assembly procedures.

Resistors are designated by the color code and the resistance value. The symbol "Ω" means ohms (K = 1,000; M = 1,000,000). Capacitors are designated by their value and type. The symbol "μF" means microfarad, and "pF" means picofarad. 1 μF is equal to 1,000,000 pF.

Due to the small foil area around the circuit board holes and the small areas between foils, it is necessary to use the utmost care to prevent solder bridges between adjacent foil areas. Use a minimum amount of solder and do not heat components excessively. Diodes, transistors, and IC's can be damaged if subjected to excessive amounts of heat. Use a soldering iron rated at 15 to 25 watts. Its tip should be no wider than 1/16" at the widest dimension; a pyramid or chisel shaped tip is best. This type of soldering iron will make the kit easier to assemble with less chance of solder bridges occurring. Solder a part, or group of parts, only when instructed to do so.

NOTE: If a small wattage, small-tip soldering iron is not available, proceed as follows: Be sure your soldering iron is cool. Then wrap the bare wire, supplied with this kit, tightly around the soldering iron tip as shown in Figure 1-1. Allow approximately 1/4" of wire to extend beyond the end of the soldering iron. Cut the wire end to a chisel shape as shown. You may have to replace this arrangement occasionally as the wire wrap will loosen after it has been heated for some time.

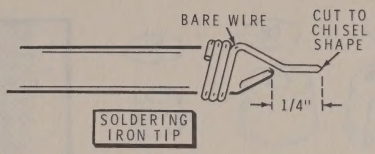


Figure 1-1

Most parts will be installed on the top (the side with the component outlines) of the circuit board, and the leads will be soldered to the foil (other) side. Solder the leads only to the foil side of the board unless specifically instructed to do otherwise. Due to the nature of the board, solder may be drawn up through the circuit board plated-through holes to the top (component side) of the circuit board. This is normal.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
#6 Hardware				
F1	250-116	11	6-32 x 1/4" black screw	.05
F2	250-587	5	6-32 x 5/16" screw	.05
F3	250-89	2	6-32 x 3/8" screw	.05
F4	250-357	1	6-32 x 3/8" black nylon screw	.05
F5	250-8	7	#6 x 3/8" sheet metal screw	.05
F6	250-162	6	6-32 x 1/2" screw	.05
F7	252-3	9	6-32 nut	.05
F8	254-1	9	#6 lockwasher, internal tooth	.05
F9	254-6	12	#6 lockwasher, external tooth	.05
F10	253-2	2	#6 fiber shoulder washer	.05
F11	259-1	2	#6 solder lug	.05
#8 Hardware				
G1	250-137	2	8-32 x 3/8" screw	.05
G2	252-4	2	8-32 nut	.05
G3	254-2	4	#8 lockwasher	.05
Miscellaneous Hardware				
G4	255-103	6	6-32 x 5/16" spacer	.10
G5	252-7	1	Control nut	.05
G6	259-10	1	Control solder lug	.05
G7	260-16	2	Alligator clip	.10
G8	266-846	2	Wire bail	.75
INSULATORS-GASKETS-COMPOSITION ITEMS				
H1	73-34	2	Clip insulators	.15
H2	73-39	1	Foam rubber	.15/ft
H3	75-52	1	Switch insulator	.15
H4	75-71	1	Strain relief	.15
H5	75-704	1	Transistor insulator	.15
H6	261-16	1	1/2" round foot	.05
H7	261-36	2	3/4" round foot	.15
H8	261-35	2	1" round foot	.20

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
CABLE-WIRE				
	89-23	1	Line cord	1.25
	134-237	1	Cable assembly	3.30
	340-11	1	#12 bare wire	.10/ft
	344-50	1	Black wire	.05/ft
	344-51	1	Brown wire	.05/ft
	344-3	1	Red wire	.05/ft
	344-53	1	Orange wire	.05/ft
	344-55	1	Green wire	.05/ft
	344-56	1	Blue wire	.05/ft
	344-57	1	Violet wire	.05/ft
	344-58	1	Gray wire	.05/ft
	344-59	1	White wire	.05/ft
CHASSIS-CABINET PARTS				
J1	90-588-1	1	Cabinet shell	5.95
J2	200-647-1	1	Chassis	3.65
J3	203-1452	1	Front panel	4.15
J4	210-58	1	Bezel	3.40
MISCELLANEOUS				
	54-816	1	Power transformer	7.50
	85-1231-1	1	Printed circuit board	17.20
K1	352-13	1	Silicone grease	.25
	391-34	1	Blue and white identification label	
K2	404-414	1	1 MHz crystal	15.05
K3	421-33	1	1/4-ampere, 3AG, slow-blow fuse	.50
K4	422-1	1	Fuse block	.40
K5	490-5	1	Nut starter	.15
K6	490-111	1	Integrated circuit puller	.15
K7	490-109	1	White alignment tool	.15
	390-362	1	Fuse replacement label	.15
	597-260	1	Parts Order Form	
	597-308	1	Kit Builders Guide	
		1	Manual (See front cover for part number.)	2.00
			Solder (Additional 3' rolls of solder, #331-6, can be ordered for 25 cents each.)	

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage, and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

STEP-BY-STEP ASSEMBLY

Before starting to assemble this kit, read the "Kit Builders Guide" for complete information on wiring, soldering, and step-by-step assembly procedures.

Resistors are designated by the color code and the resistance value. The symbol "Ω" means ohms (K = 1,000; M = 1,000,000). Capacitors are designated by their value and type. The symbol "μF" means microfarad, and "pF" means picofarad. 1 μF is equal to 1,000,000 pF.

Due to the small foil area around the circuit board holes and the small areas between foils, it is necessary to use the utmost care to prevent solder bridges between adjacent foil areas. Use a minimum amount of solder and do not heat components excessively. Diodes, transistors, and IC's can be damaged if subjected to excessive amounts of heat. Use a soldering iron rated at 15 to 25 watts. Its tip should be no wider than 1/16" at the widest dimension; a pyramid or chisel shaped tip is best. This type of soldering iron will make the kit easier to assemble with less chance of solder bridges occurring. Solder a part, or group of parts, only when instructed to do so.

NOTE: If a small wattage, small-tip soldering iron is not available, proceed as follows: Be sure your soldering iron is cool. Then wrap the bare wire, supplied with this kit, tightly around the soldering iron tip as shown in Figure 1-1. Allow approximately 1/4" of wire to extend beyond the end of the soldering iron. Cut the wire end to a chisel shape as shown. You may have to replace this arrangement occasionally as the wire wrap will loosen after it has been heated for some time.

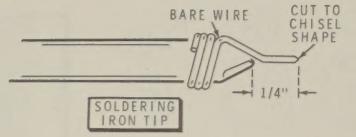


Figure 1-1

Most parts will be installed on the top (the side with the component outlines) of the circuit board, and the leads will be soldered to the foil (other) side. Solder the leads only to the foil side of the board unless specifically instructed to do otherwise. Due to the nature of the board, solder may be drawn up through the circuit board plated-through holes to the top (component side) of the circuit board. This is normal.

STEP-BY-STEP ASSEMBLY

kit, read the "Kit Builders
n on wiring, soldering, and

olor code and the resistance
ohms (K = 1,000; M =
nated by their value and
icrofarad, and "pF" means
000 pF.

the circuit board holes and
t is necessary to use the
dges between adjacent foil
of solder and do not heat
transistors, and IC's can be
e amounts of heat. Use a
watts. Its tip should be no
dimension; a pyramid or
type of soldering iron will
with less chance of solder
, or group of parts, only

ll-tip soldering iron is not
sure your soldering iron is
pplied with this kit, tightly
shown in Figure 1-1. Allow

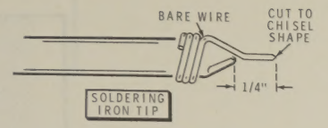
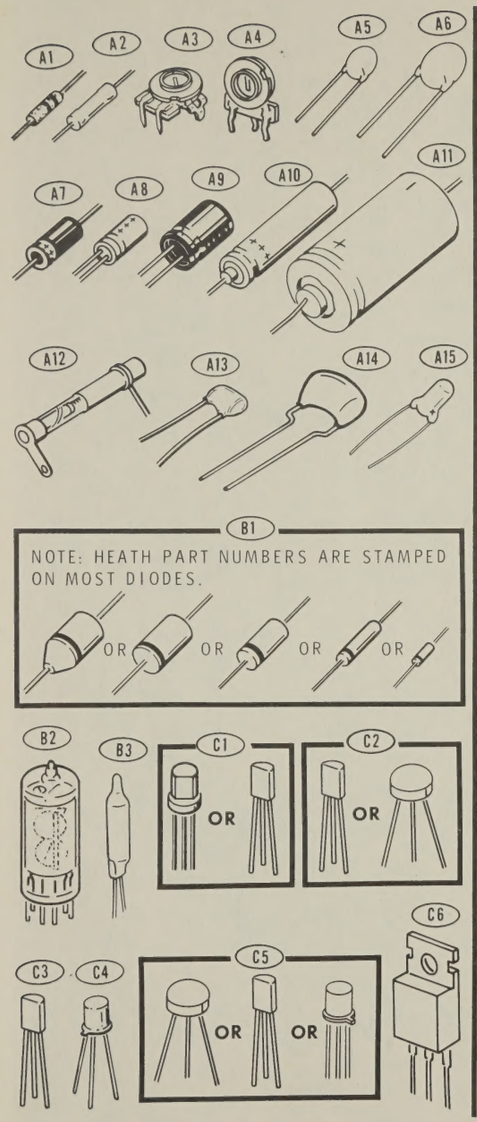


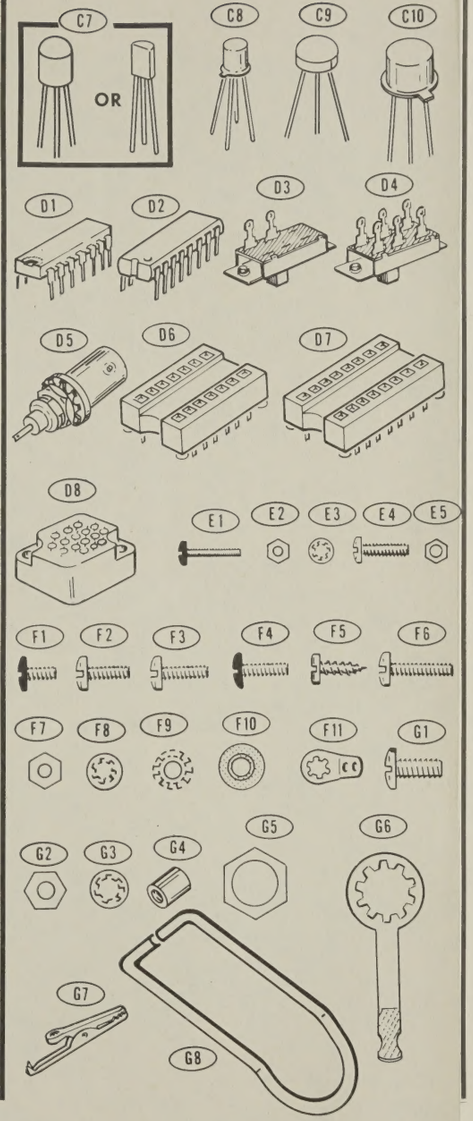
Figure 1-1

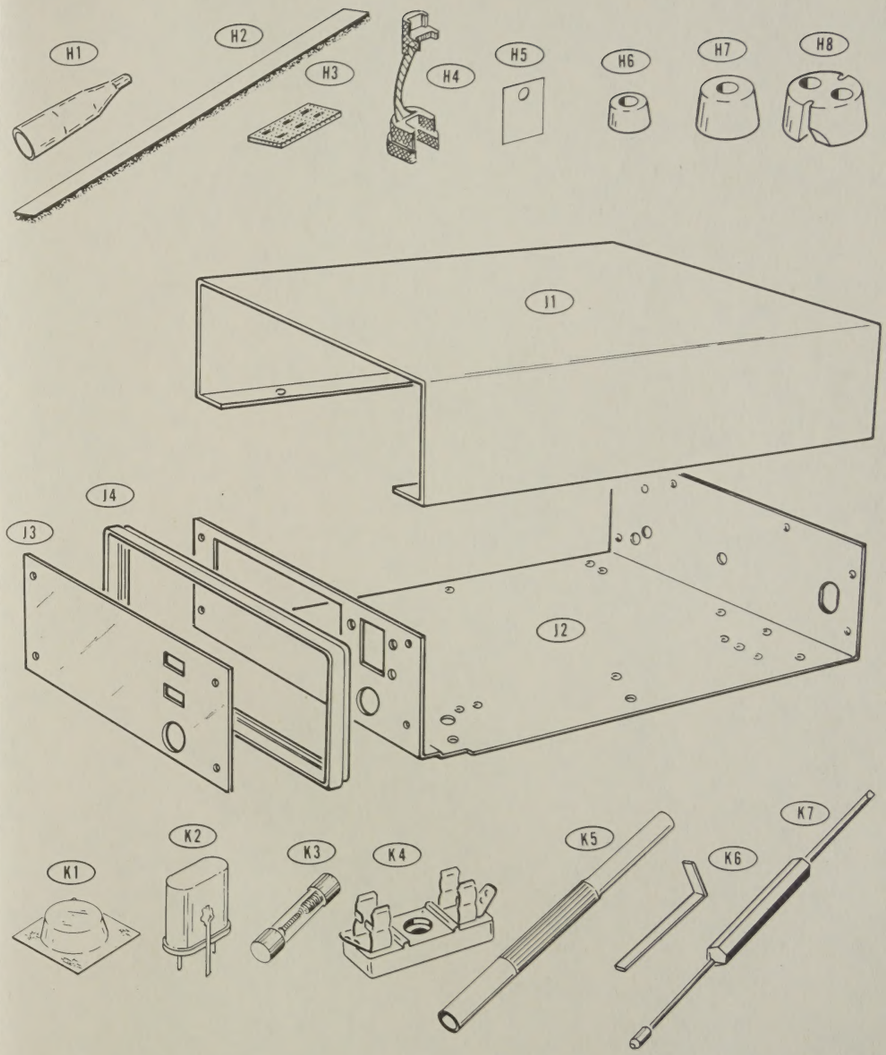
approximately 1/4" of wire to extend beyond the end of the soldering iron. Cut the wire end to a chisel shape as shown. You may have to replace this arrangement occasionally as the wire wrap will loosen after it has been heated for some time.

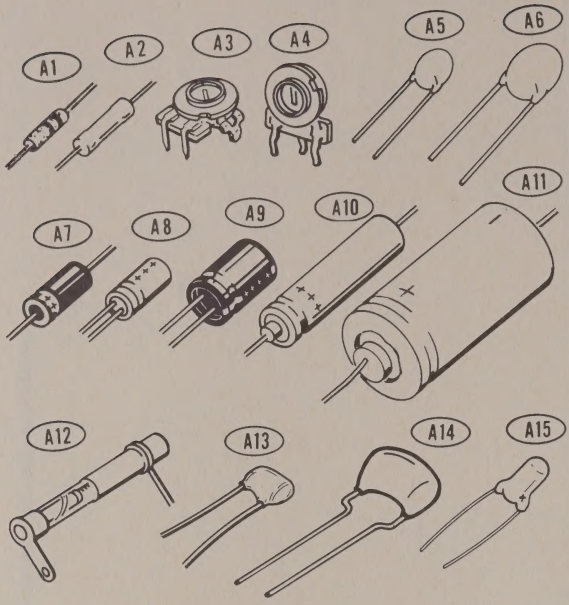
Most parts will be installed on the top (the side with the component outlines) of the circuit board, and the leads will be soldered to the foil (other) side. Solder the leads only to the foil side of the board unless specifically instructed to do otherwise. Due to the nature of the board, solder may be drawn up through the circuit board plated-through holes to the top (component side) of the circuit board. This is normal.

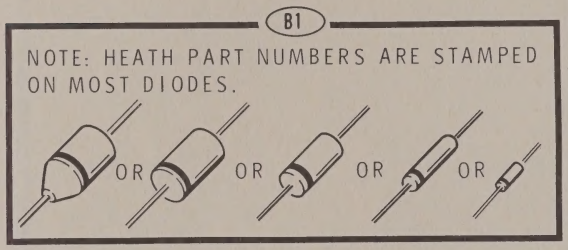
PARTS PICTORIAL

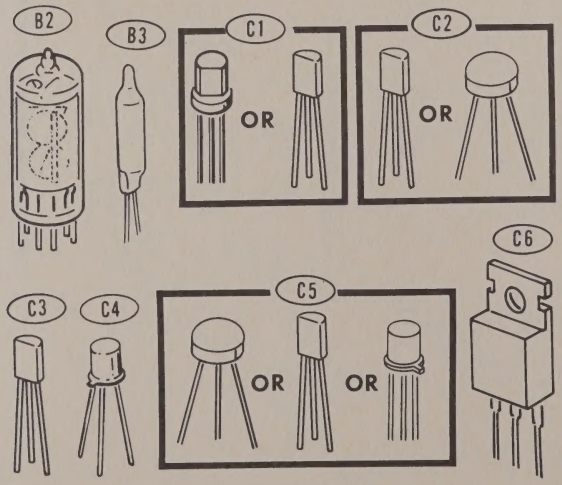


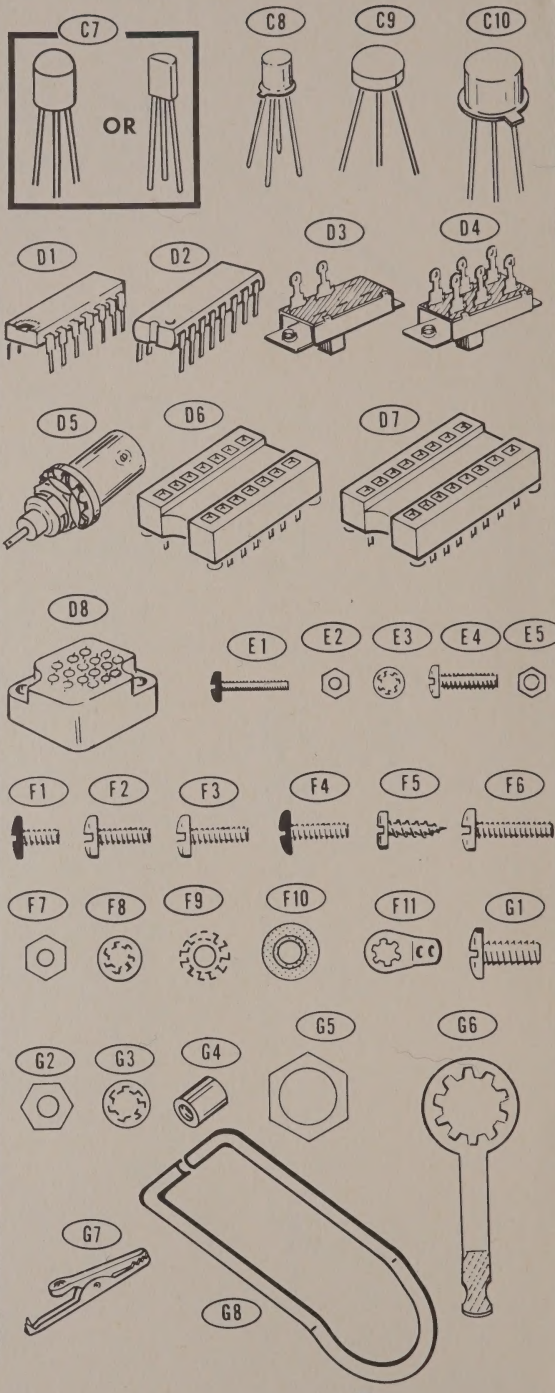




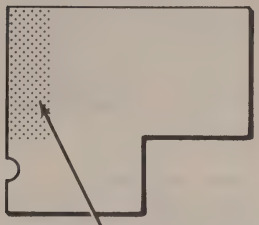

A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15


B1
NOTE: HEATH PART NUMBERS ARE STAMPED ON MOST DIODES.
OR
OR
OR
OR


B2
B3
C1
OR
C2
OR
C3
C4
C5
OR
OR
C6


C7
OR
C8
C9
C10
D1
D2
D3
D4
D5
D6
D7
D8
E1
E2
E3
E4
E5
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
G1
G2
G3
G4
G5
G6
G7
G8

IDENTIFICATION DRAWING

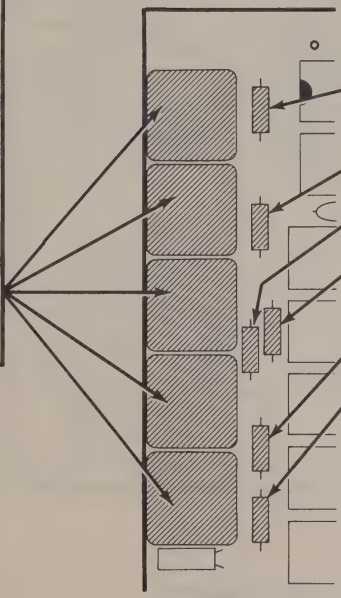


The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE: Display tube sockets will be installed in the following step. Only a small amount of pressure is required to push the socket pins into the circuit board holes. First, make sure the socket pins are properly aligned with the circuit board holes; straighten pins as required. Socket pins 1 and 8 must be toward the left edge of the circuit board. After positioning, be sure the socket is down flat against the circuit board. It may help you avoid solder bridges if the outside rows of pins on each socket are soldered last.

( ) Install five display tube sockets at V1 through V5. Solder the socket pins to the foil as each socket is installed.



CONTINUE

( ) 15 kΩ (brown-green-orange).

( ) 15 kΩ (brown-green-orange).

( ) 100 kΩ (brown-black-yellow).

( ) 15 kΩ (brown-green-orange).

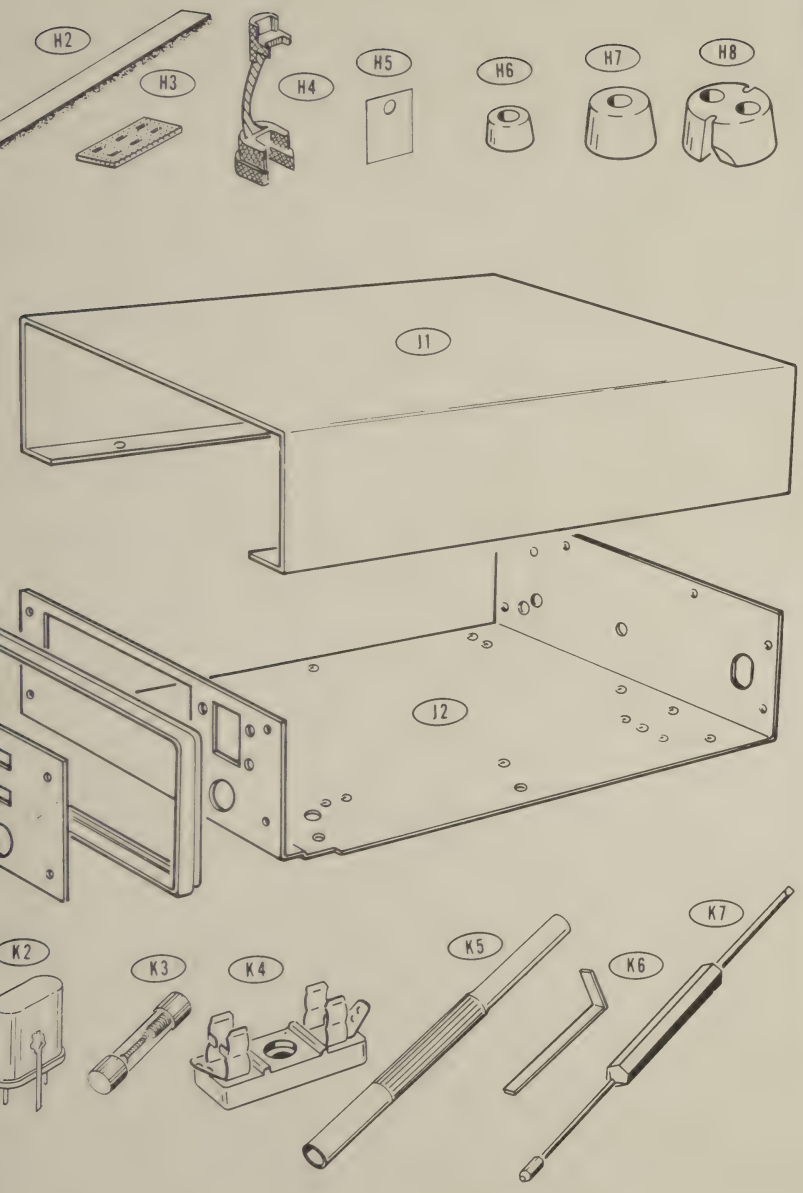
( ) 15 kΩ (brown-green-orange).

( ) 15 kΩ (brown-green-orange).

SAFETY WARNING: Avoid eye injury when you clip off excess leads. We suggest that you wear glasses, or at least clip the leads so the ends will not fly toward your eyes.

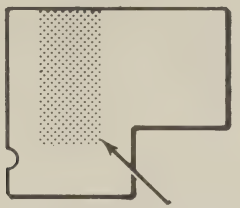
( ) Solder all leads to the foil and cut off excess lead lengths.

PICTORIAL 1-2



CIRCUIT BOARD ASSEMBLY

IDENTIFICATION DRAWING



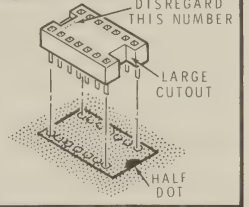
The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE: Only part of the circuit board is shown in the following Pictorials. An identification drawing at the top of each Pictorial shows the area of the circuit board to be assembled.

Position the circuit board as shown in the identification drawing. Then complete each step on Pictorial 1-1 through 1-12.

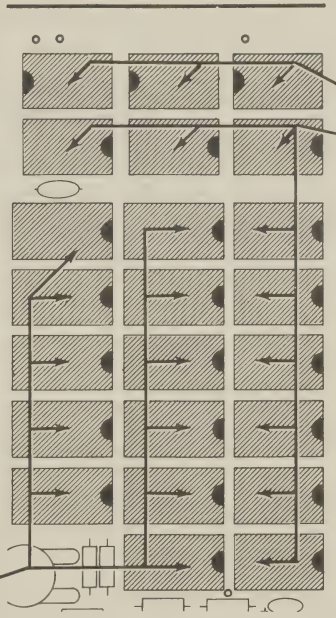
NOTE: Both 14-pin and 16-pin dual-in-line IC's and sockets are used in this kit. Match the cutout on one end of each socket to the half dot on the socket outline on the circuit board. Solder the pins of each socket to the foil as it is installed. Make sure all pins are in their holes before soldering, and that the socket is flat against the board.



FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN...

WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

( ) Eleven 16-pin sockets at IC1 thru IC5, IC26, and IC6 thru IC10.



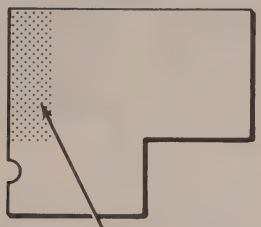
CONTINUE

( ) Three 14-pin sockets at IC18, IC19, and IC20.

( ) Nine 14-pin sockets at IC25. IC27, and IC11 through IC17.

PICTORIAL 1-1

IDENTIFICATION DRAWING

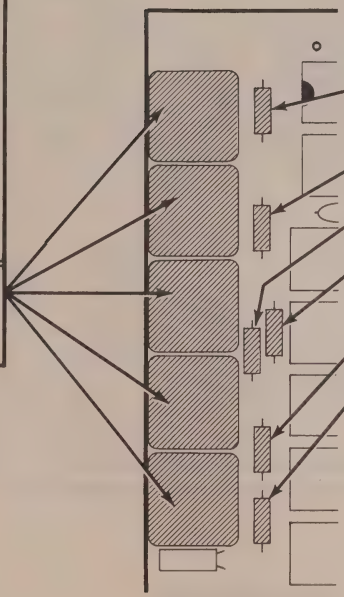


The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE: Display tube sockets will be installed in the following step. Only a small amount of pressure is required to push the socket pins into the circuit board holes. First, make sure the socket pins are properly aligned with the circuit board holes; straighten pins as required. Socket pins 1 and 8 must be toward the left edge of the circuit board. After positioning, be sure the socket is down flat against the circuit board. It may help you avoid solder bridges if the outside rows of pins on each socket are soldered last.

( ) Install five display tube sockets at V1 through V5. Solder the socket pins to the foil as each socket is installed.



CONTINUE

( ) 15 kΩ (brown-green-orange).

( ) 15 kΩ (brown-green-orange).

( ) 100 kΩ (brown-black-yellow).

( ) 15 kΩ (brown-green-orange).

( ) 15 kΩ (brown-green-orange).

( ) 15 kΩ (brown-green-orange).

SAFETY WARNING: Avoid eye injury when you clip off excess leads. We suggest that you wear glasses, or at least clip the leads so the ends will not fly toward your eyes.

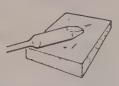
( ) Solder all leads to the foil and cut off excess lead lengths.

PICTORIAL 1-2

START

FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN...

WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.



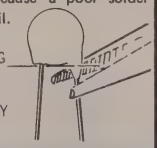
( ) 1000 Ω (brown-black-red).

( ) 14-pin socket at IC22. Solder each pin to the foil.

( ) 14-pin socket at IC24. Solder each pin to the foil.

Before you install a disc capacitor, remove from its leads any excess body coating material which could protrude through the circuit board and cause a poor solder connection to the foil.

REMOVE COATING EVEN WITH BOTTOM OF CAPACITOR BODY



( ) .01 μF disc.

( ) 1000 Ω (brown-black-red).

( ) 1000 Ω (brown-black-red).

( ) Solder each lead to the foil and cut off excess lead lengths.

( ) 1000 Ω (brown-black-red).

( ) 1000 Ω (brown-black-red).

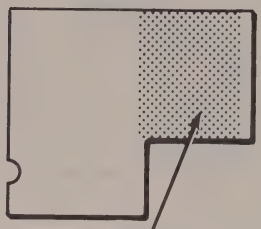
( ) .01 μF disc.

( ) 680 pF disc.

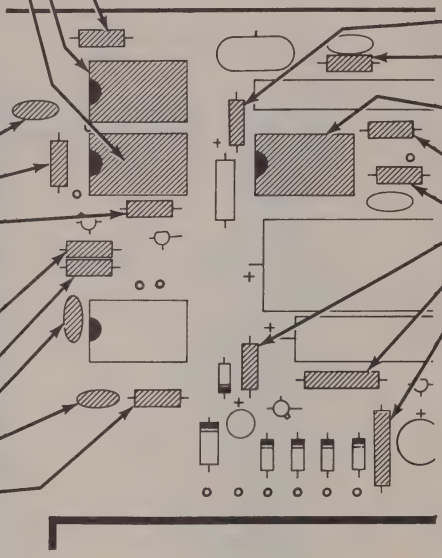
( ) 390 Ω (orange-white-brown).

( ) Solder all leads to the foil and cut off excess lead lengths.

IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.



CONTINUE

( ) 680 Ω (blue-gray-brown).

( ) 150 Ω (brown-green-brown).

( ) 14-pin socket at IC21. Solder each pin to the foil.

( ) 680 Ω (blue-gray-brown).

( ) 270 Ω (red-violet-brown).

( ) 270 Ω (red-violet-brown).

( ) 794 Ω, 1%.

( ) 550 Ω, 1%.

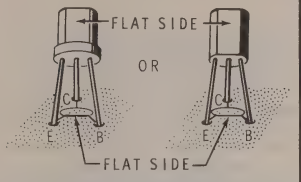
( ) Solder all leads to the foil and cut off excess lead lengths.

PICTORIAL 1-3

START

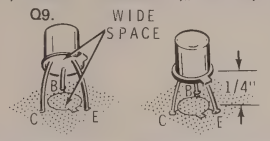
NOTE: The following transistor may be one of the two types shown below. Determine which type you received and insert the transistor leads into the corresponding E, C, and B holes in the circuit board as shown. Position the transistor body 1/4" above the circuit board, solder each lead to the foil, and cut off the excess lead lengths.

( ) Transistor 2N3393 (#417-118) at Q8.



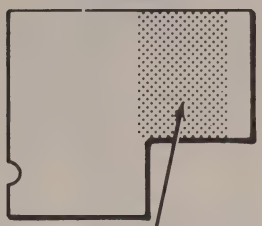
NOTE: For the following step, position the tab on the transistor body near the E on the circuit board, as shown, and insert the leads into the holes. Position the transistor body 1/4" above the circuit board, solder each lead to the foil, and cut off excess lead lengths.

( ) 2N2369 transistor (#417-154) at Q9.

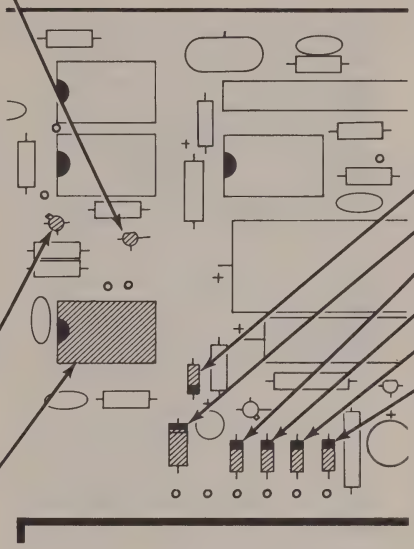


( ) 14-pin socket at IC23. Solder each pin to the foil.

IDENTIFICATION DRAWING

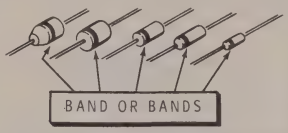


The steps performed in this Pictorial are in this area of the circuit board.



CONTINUE

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



( ) Zener diode (#56-36) at ZD2.

( ) Diode 1N2071 (#57-27) at D7.

( ) Diode 1N4002 (#57-65) at D6.

( ) Diode 1N4002 (#57-65) at D5.

( ) Diode 1N4002 (#57-65) at D4.

( ) Diode 1N4002 (#57-65) at D3.

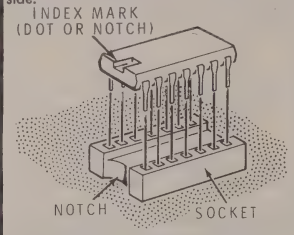
( ) Solder all leads to the foil and cut off excess lead lengths.

PICTORIAL 1-4

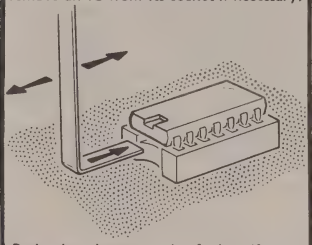
START

In the following steps, install IC's (integrated circuits) in the designated sockets. Be careful to match the index mark on each IC to the notch in the end of its socket.

Handle IC's with care as their pins are easily bent. Before applying downward pressure to an IC, make sure each IC pin is centered in its proper socket aperture. After insertion, make sure the IC body is flat in the socket and not tilted to one side.

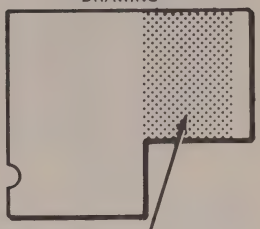


NOTE: An IC Lifter has been furnished to remove an IC from its socket if necessary.

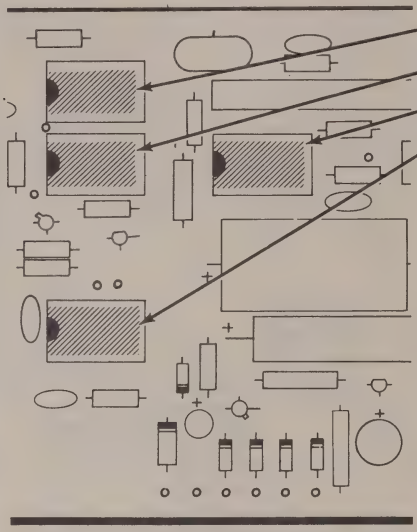


Push the shorter end of the lifter in between the IC and the socket and rock the longer portion back and forth. Be very careful as the IC pins are very easily bent.

IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

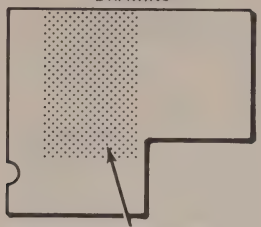


CONTINUE

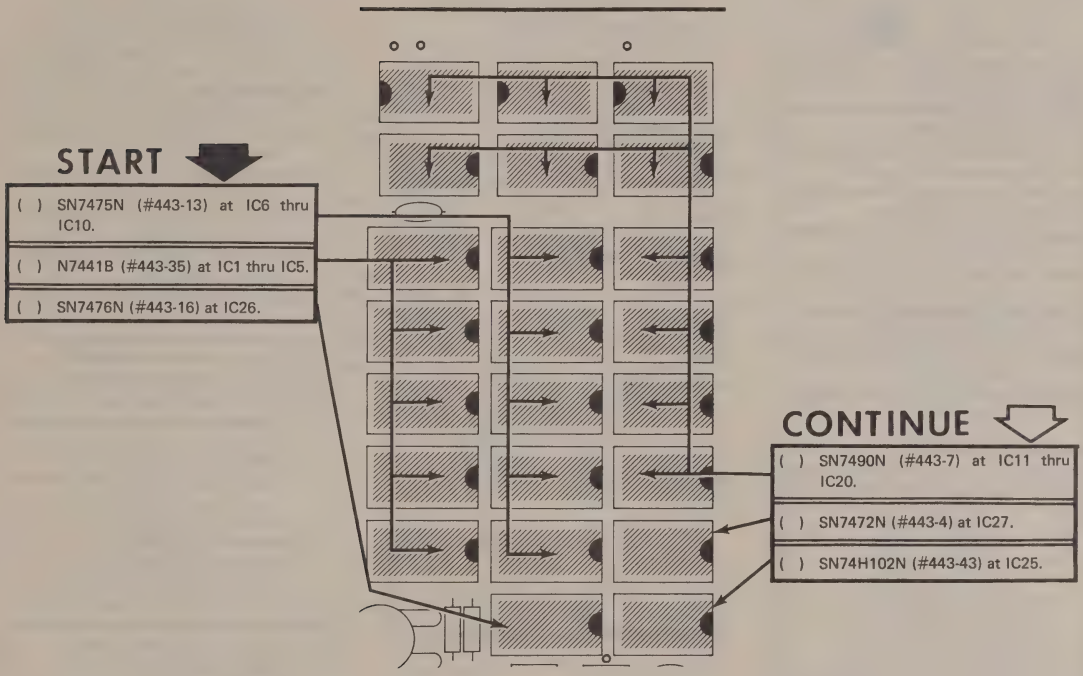
- ( ) SN7400N (#443-1) at IC22.
- ( ) SN7473N (#443-5) at IC24.
- ( ) SN7400N (#443-1) at IC21.
- ( ) SN7400N (#443-1) at IC23.

PICTORIAL 1-5

IDENTIFICATION
DRAWING

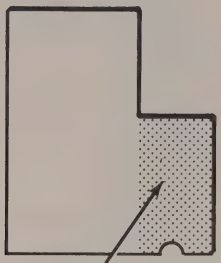


The steps performed in this Pictorial are in this area of the circuit board.


START
( ) SN7475N (#443-13) at IC6 thru IC10.
( ) N7441B (#443-35) at IC1 thru IC5.
( ) SN7476N (#443-16) at IC26.
CONTINUE
( ) SN7490N (#443-7) at IC11 thru IC20.
( ) SN7472N (#443-4) at IC27.
( ) SN74H102N (#443-43) at IC25.

PICTORIAL 1-6

IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE THE CHANGE IN CIRCUIT BOARD POSITION.

( ) 270 Ω (red-violet-brown).

( ) Zener diode (#56-63) at ZD1.

( ) 1800 Ω (brown-gray-red).

( ) 390 Ω (orange-white-brown).

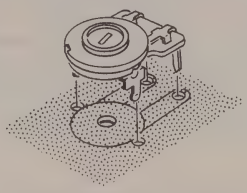
( ) 150 Ω (brown-green-brown).

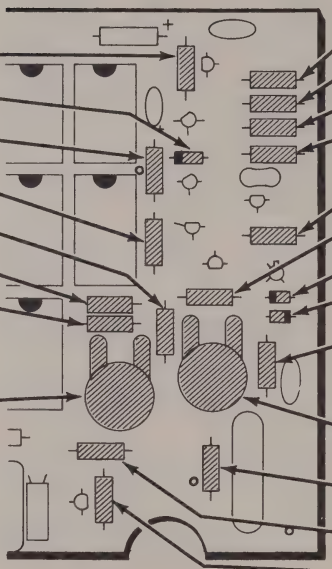
( ) 1000 Ω (brown-black-red).

( ) 68 Ω (blue-gray-black).

( ) Solder each lead to the foil and cut off excess lead lengths.

( ) 3000 Ω control (#10-387). Solder the four leads to the foil.





CONTINUE

( ) 100 Ω (brown-black-brown).

( ) 47 Ω (yellow-violet-black).

( ) 1000 Ω (brown-black-red).

( ) 100 Ω (brown-black-brown).

( ) 220 Ω (red-red-brown).

( ) 220 Ω (red-red-brown).

( ) Diode 1N4149 (#56-56) at D2.

( ) Diode 1N4149 (#56-56) at D1.

( ) 100 kΩ (brown-black-yellow).

( ) Solder each lead to the foil and cut off excess lead lengths.

( ) 500 Ω control (#10-381). Solder the four leads to the foil.

( ) 1 MΩ (brown-black-green).

( ) 27 kΩ (red-violet-orange).

( ) 100 kΩ (brown-black-yellow).

( ) Solder each lead to the foil and cut off excess lead lengths.

PICTORIAL 1-7

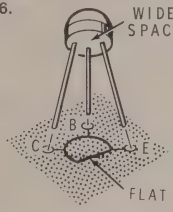
START

NOTES:

1. For clarity, a transistor installation detail may show a different view than the outline on the circuit board Pictorial. When you install a transistor it may be helpful to turn the circuit board to agree with the installation detail view.

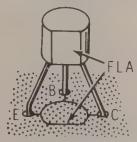
2. When installing transistors, place the lettered leads of each transistor in the corresponding holes of the circuit board. Position the transistor 1/4" above the circuit board. Solder all leads of each transistor as it is installed. Cut off the excess lead lengths.

( ) Transistor 2N4258A (#417-260) at Q6.



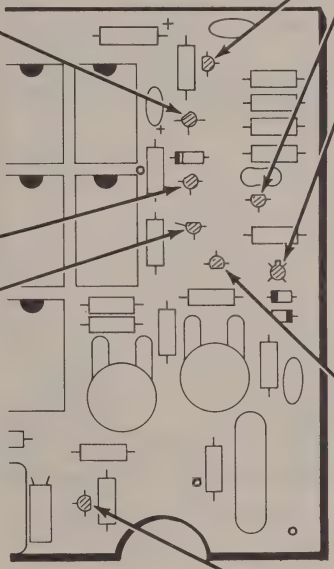
( ) Transistor 2N4258A (#417-260) at Q5.

( ) Transistor MPS6520 (#417-134) at Q4.



IDENTIFICATION DRAWING

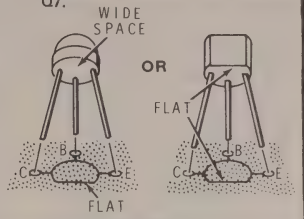
The steps performed in this Pictorial are in this area of the circuit board.



PICTORIAL 1-8

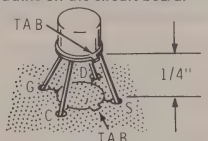
CONTINUE

( ) Transistor 2N3563 (#417-125) at Q7.



( ) Transistor 2N3563 (#417-125) at Q3.

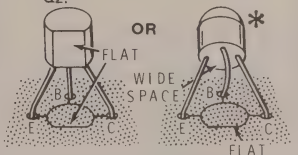
( ) Transistor SFC2912 (#417-251) at Q1. Illustrated to show the tab on the case. When installing, be sure to match the transistor tab to the tab outline on the circuit board.



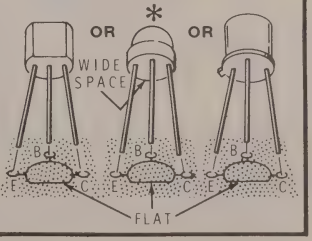
NOTE: The transistor installed in each of the next two steps will be one of the types illustrated in that step. Determine which type you received and insert the transistor leads into the corresponding C, B, and E holes in the circuit board.

*Notice in particular that the transistor marked with an asterisk must be installed with its wide space opposite to the flat marked on the circuit board.

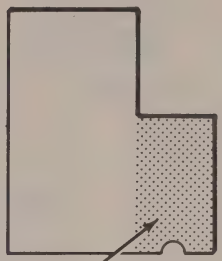
( ) Transistor 2N4121 (#417-235) at Q2.



( ) Transistor ETS083 (#417-173) at Q10.



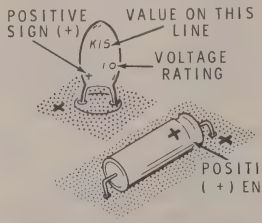
IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

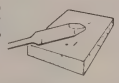
NOTE: When you install electrolytic capacitors, always match the colored or the positive (+) marked end of the capacitor with the positive (+) mark on the circuit board.



( ) 10 μF electrolytic (#25-54).

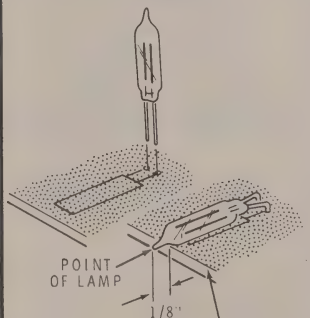
( ) 10 μF tantalum (#25-220).

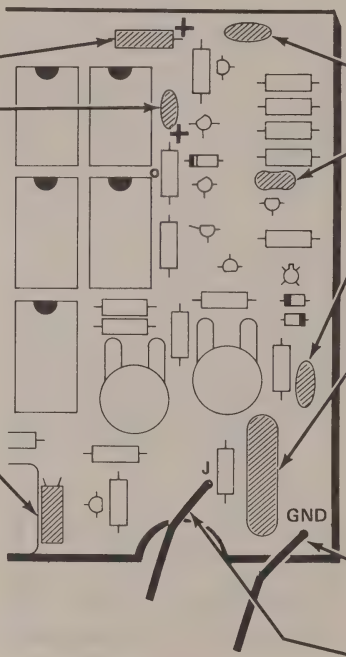
FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN... WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.



( ) Solder each lead to the foil and cut off excess lead lengths.

( ) Insert the leads of the NE-2H neon lamp into the two holes at V6. Push the lamp down and then bend it over so the lamp is flat against the circuit board and the point of the lamp protrudes 1/8" beyond the edge of the board. Make sure the leads do not touch each other. Solder the leads to the foil and cut off the excess lead lengths.





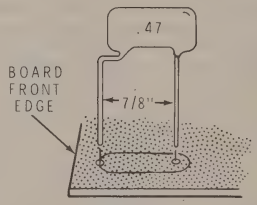
CONTINUE

( ) .01 μF disc.

( ) 68 pF mica.

( ) 10 pF disc.

( ) .47 μF metalized film. Form the capacitor leads as shown before mounting. Solder each lead to the foil and cut off excess lead lengths.

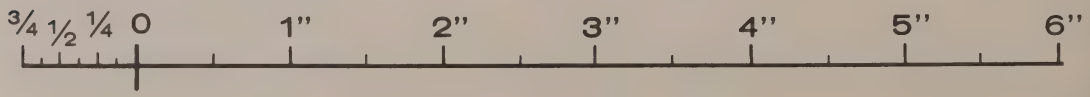


( ) Cut a 2-1/2" length of violet wire and remove 1/4" of insulation from each end. Insert one end in the hole at GND and solder it to the foil.

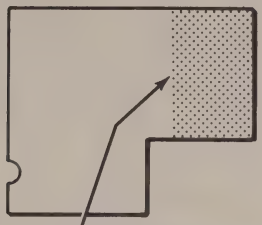
( ) Cut a 2" white wire and remove 1/4" of insulation from each end. Insert one end in the hole at J and solder it to the foil.

( ) Cut off any excess wire lengths.

PICTORIAL 1-9



IDENTIFICATION DRAWING



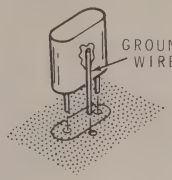
The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE THE CHANGE IN CIRCUIT BOARD POSITION.

( ) 10 pF disc.

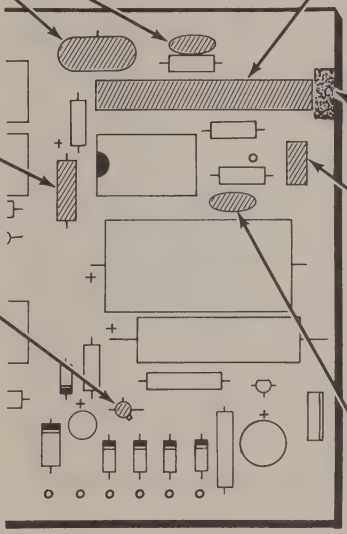
( ) 1 MHz crystal. The illustration is from the back so you can see the ground wire.



( ) 10 μF electrolytic (#25-54). Match the + marks.

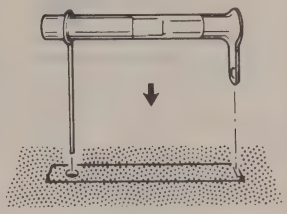
( ) Transistor SGC5282 (#417-269) at Q11.

( ) Solder all leads to the foil and cut off excess lead lengths.



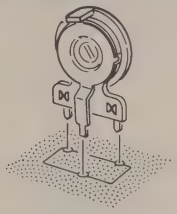
CONTINUE

( ) 1-30 pF piston trimmer. Space the trimmer body 1/16" above the circuit board. Solder the leads to the foil and cut off excess lead lengths. Be sure the trimmer body does not touch the crystal case.



( ) Cut a 1/2" length from the strip of foam rubber. Remove the protective paper backing and press the adhesive side down over the foil strip in front of the piston trimmer.

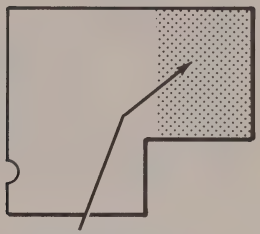
( ) 500 Ω control (#10-918). Solder the leads to the foil.



( ) .005 disc. Solder the leads to the foil and cut off excess lead lengths.

PICTORIAL 1-10

IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

( ) 2000 μF electrolytic. Match the + marks.

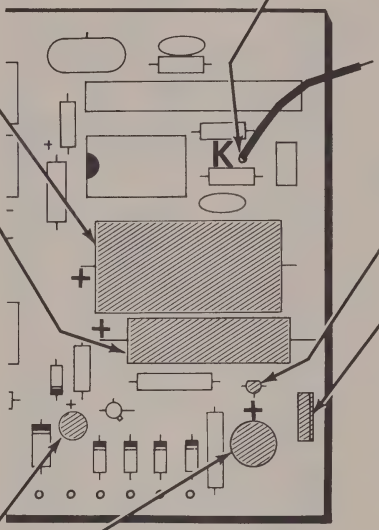
( ) 200 μF electrolytic.

( ) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: When installing the following electrolytic capacitors, match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board. Solder the leads to the foil and cut off excess lead lengths.

( ) 10 μF electrolytic (#25-257).

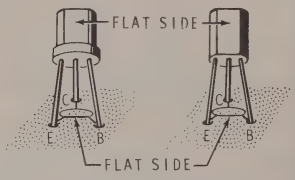
( ) 100 μF electrolytic.



CONTINUE

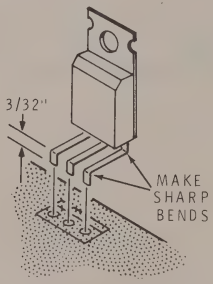
( ) Remove 1/4" of insulation from each end of a 3" black wire. Insert one end in the hole at K and solder the wire to the foil. Cut off the excess lead lengths.

NOTE: The following transistor may be one of the two types shown below. Determine which type you received and insert the transistor leads into the corresponding E, C, and B holes in the circuit board as shown.



( ) Transistor 2N3393 (#417-118) at Q13. Solder the leads to the foil and cut off the excess lead lengths.

( ) Transistor 2N5294 (#417-175). Bend the three leads forward; then curve the lead ends downward, as shown. Insert the leads into the three holes until the ends just appear on the foil side. Solder each lead to the foil. The back of the transistor will extend out over the edge of the board.



PICTORIAL 1-11

START

( ) Cut the following wires to length and remove 1/4" of insulation from each end of each wire. Save the pieces remaining for use later.

10-3/4" orange
9-3/4" brown
9-3/4" gray
9-1/2" green
9-1/4" blue
8" violet
8" white
4-3/4" black

NOTE: In each of the following steps, insert one end of the wire into the circuit board hole and solder it to the foil. Cut off the excess wire lengths.

( ) Violet wire to H.

( ) White wire to G.

( ) Orange wire to F.

( ) .01 μF disc. Solder the leads to the foil and cut off the excess lead lengths.

( ) Brown wire to E.

( ) Gray wire to D.

( ) Blue wire to B.

( ) Green wire to C.

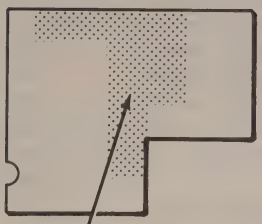
( ) Black wire to A.

( ) Carefully inspect the circuit board to see that all connections are soldered and that there are no solder bridges between foils. A magnifying glass will be helpful.

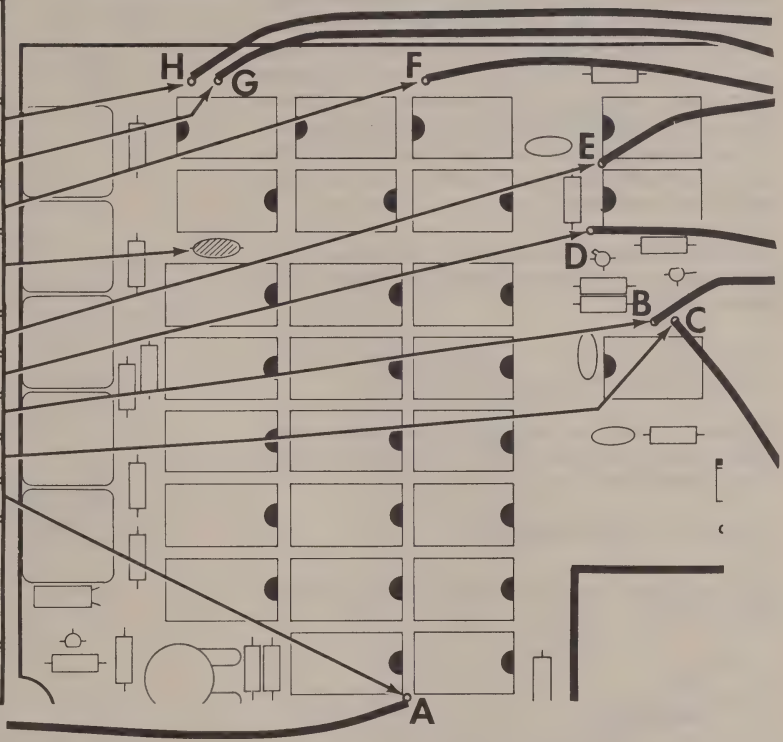
( ) Lay the circuit board aside. It will be installed later.

FINISH

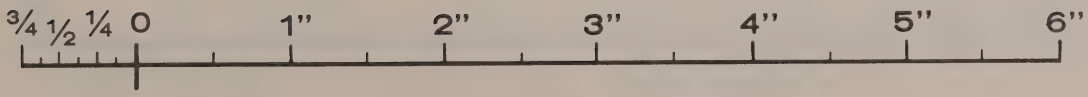
IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.



PICTORIAL 1-12



CHASSIS ASSEMBLY

The illustrations in the assembly sections of the Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details are used in addition to the Pictorials to illustrate a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.

Look at the "Chassis Photo" (Page 50) from time to time to see the actual positions of wires and components.

Lockwashers and nuts will be used with most screws when mounting parts. Consequently, the applicable steps will call out only the size and type of hardware used. For example, the phrase "Use 6-32 x 1/4" hardware" means to use 6-32 x 1/4" screws, one or more #6 lockwashers, and 6-32 nuts. Refer to the Details for the proper installation of hardware. Be sure to position the parts as shown in the Pictorials. Read the entire step before you perform the operation and follow the instructions carefully.

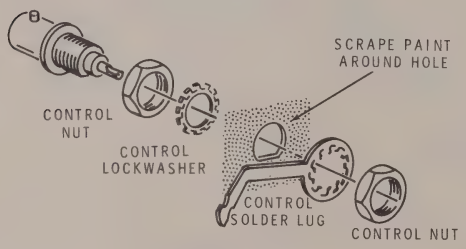
Both internal and external tooth lockwashers are used in this kit. Always use the internal tooth lockwashers unless directed otherwise.

When a step directs you to "connect" an insulated wire, first prepare its ends by removing 1/4" of insulation.

A plastic nut starter has been provided with this kit. Use it to hold and start 6-32 and 4-40 nuts on screws. Refer to the "Kit Builders Guide" for more information.

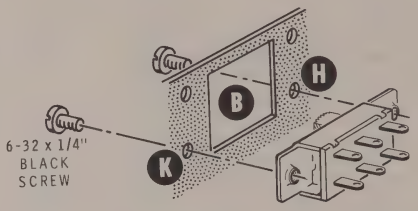
CHASSIS PARTS MOUNTING

Refer to Pictorial 2-1 (fold-out from Page 21) for the following steps.



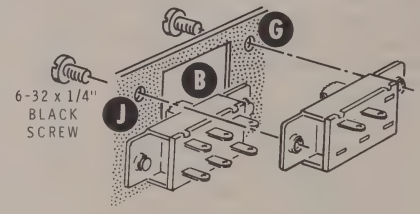
Detail 2-1A

( ) Refer to Detail 2-1A and mount a BNC connector at hole D on the front chassis lip. Scrape off the paint around the hole on the back of the panel to provide a good ground. Use a control solder lug, a control lockwasher, and control nuts. One of the control nuts is packaged with the connector. Position the leg of the control solder lug midway between holes M and K before you tighten the hardware.



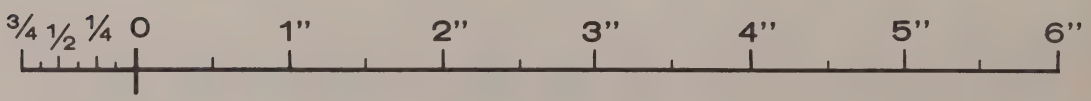
Detail 2-1B

( ) Refer to Detail 2-1B and mount a DPDT slide switch in hole B on the front chassis lip. Use 6-32 x 1/4" screws in holes H and K. Leave the mounting screws loose.



Detail 2-1C

( ) Refer to Detail 2-1C and mount an SPST slide switch in hole B on the front chassis lip with the lugs positioned as shown. Use 6-32 x 1/4" screws in holes G and J. Leave the mounting screws loose.



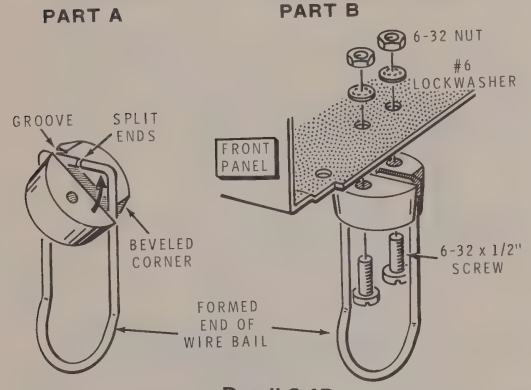
CAUTION: In the following steps you will install the front feet on the chassis. Wire bails are furnished so the viewing angle of the display may be changed. To avoid breakage, these wire bails must be positioned and installed as shown in the two-part detail.

( ) Refer to Part A of Detail 2-1D and rotate a 1" round foot within a wire bail so the split ends of the bail are positioned within the groove in the foot. Note the relative positions of the beveled corners of the foot and the formed end of the bail.

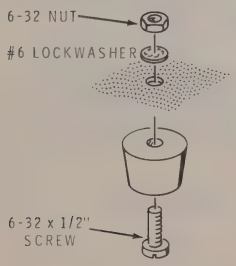
( ) Refer to Part B of the Detail and install the 1" round foot and the wire bail at hole AA on the bottom of the chassis. Position the beveled corners of the foot away from the front panel as shown. Use 6-32 x 1/2" hardware.

( ) Similarly, install the other 1" round foot and wire bail at hole AB on the chassis.

( ) Fold the bails up against the chassis.

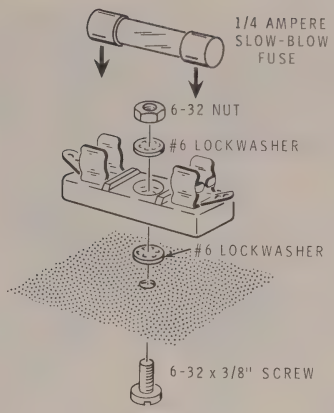


Detail 2-1D



Detail 2-1E

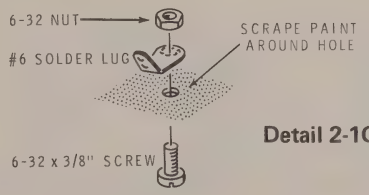
( ) Refer to Detail 2-1E and mount 3/4" round feet at holes AF and AL on the bottom of the chassis. Use 6-32 x 1/2" hardware.



Detail 2-1F

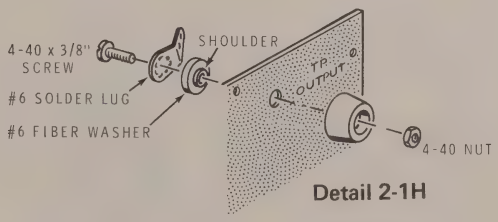
( ) Refer to Detail 2-1F and mount a fuse block on the chassis at AK. Use 6-32 x 3/8" hardware.

( ) Push the 1/4-ampere, 3AG, slow-blow fuse into the fuse block clips. NOTE: If you are going to wire this Counter to operate from 220 – 260 VAC, secure and install a 1/8-ampere fuse instead of the 1/4-ampere fuse furnished.



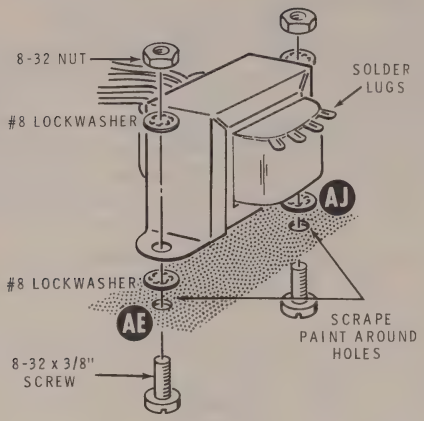
Detail 2-1G

( ) Refer to Detail 2-1G and mount a #6 solder lug at AH. Scrape the point around the hole for a good ground. Use 6-32 x 3/8" hardware.



Detail 2-1H

( ) Refer to Detail 2-1H and mount a 1/2" round foot and a #6 solder lug at R on the rear panel. Use a #6 fiber shoulder washer, a 4-40 x 3/8" screw, and a 4-40 nut. Do not overtighten the hardware as the round foot can be damaged.



Detail 2-1J

( ) Refer to Detail 2-1J and mount the power transformer at AE and AJ. Scrape the paint around each mounting hole. Position the four solder lugs toward the edge of the chassis. Use 8-32 x 3/8" hardware. Note the lockwashers used.

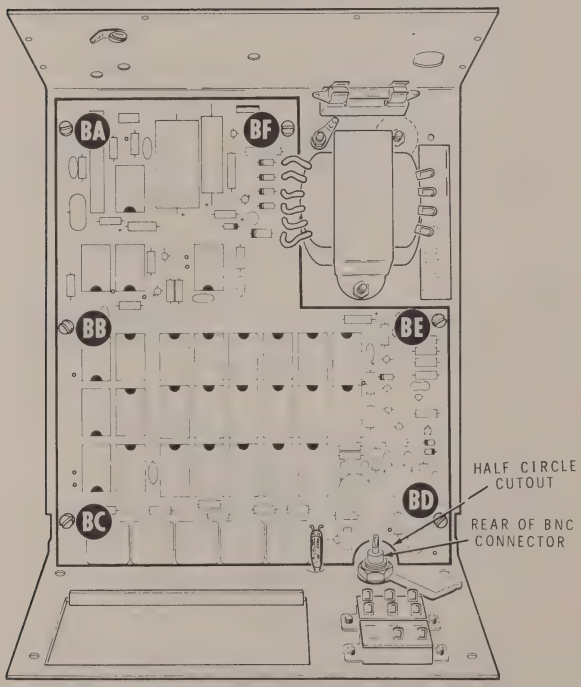
( ) Write in "1/4-Amp, 3AG" or "1/8-Amp, 3AG," as appropriate, in the space above the lines on the fuse label.

( ) Remove the protective covering from the back of the fuse label and press it down against the chassis in the location shown in the Pictorial. Do not cover any holes with the label.

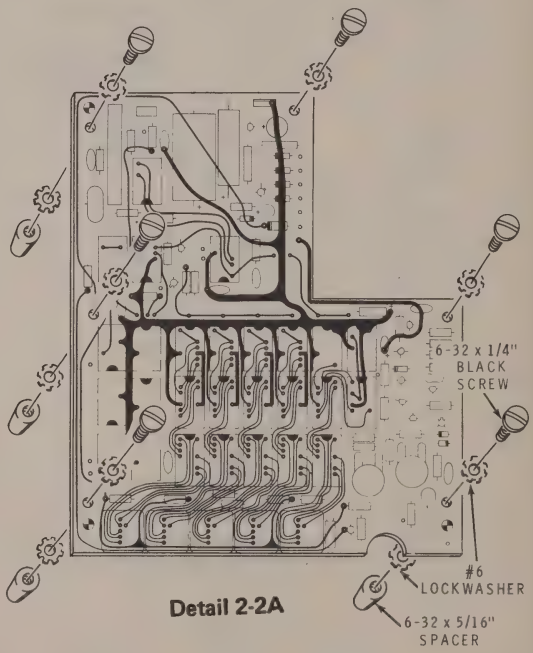
CIRCUIT BOARD MOUNTING

Refer to Pictorial 2-2 for the following steps.

( ) Refer to Detail 2-2A and mount 6-32 x 5/16" spacers on the foil side of the circuit board at BA, BB, BC, BD, BE, and BF. Use a 6-32 x 1/4" black screw and two #6 external tooth lockwashers at each hole. Tighten screw BF. Leave the other screws loose.



PICTORIAL 2-2



Detail 2-2A

CAUTION: In the following step, be sure you place the red transformer lead in the hole marked "red" on the circuit board.

( ) Place the circuit board on edge in the chassis as shown in Detail 2-2B. Then connect the six transformer leads to the appropriate holes in the circuit board (S-6) and cut off the excess lead lengths on the foil side of the board.

( ) Insert the five display tubes into their sockets. Place one hand on the foil side of the circuit board to support the sockets as you apply downward pressure. Make sure the numbers in the tubes face toward the edge of the circuit board and that the tubes are firmly seated in their sockets.

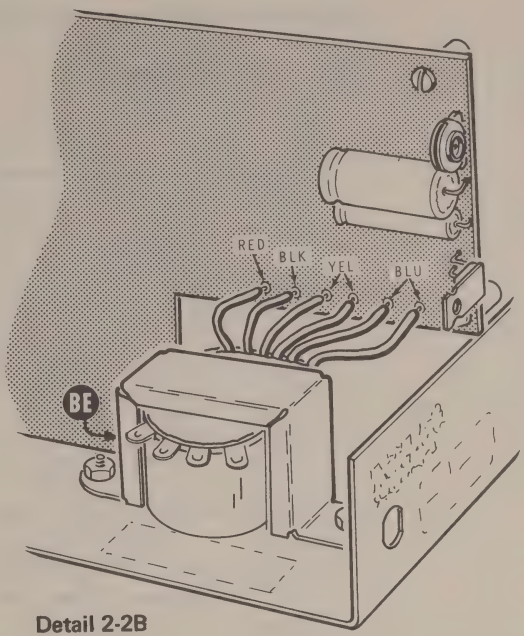
( ) Lower the circuit board to a horizontal position. Then carefully position the circuit board so the half-circle cutout at the front, right-hand corner is under the rear part of the BNC connector. Be sure the tip of the neon lamp enters the hole provided for it.

( ) Refer to Detail 2-2C and install a 6-32 x 1/4" black screw at AG. Leave the screw loose. If the spacer threads are not properly aligned with the circuit board hole, loosen screw BF and adjust the spacer. Then retighten screw BF.

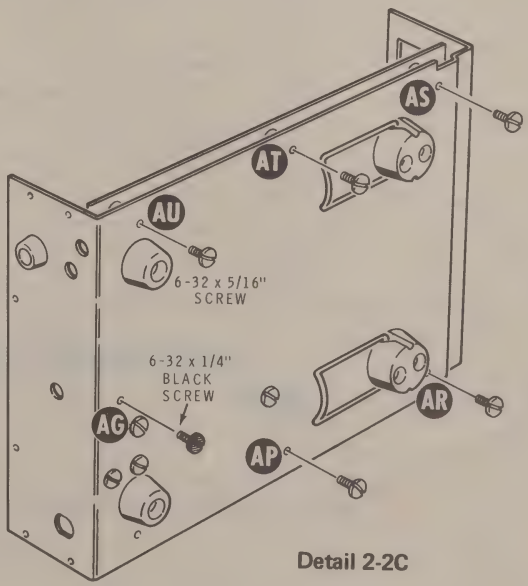
( ) Push the circuit board forward against the back of the front panel. Hold it in this position and tighten the screw at AG.

( ) Install a 6-32 x 5/16" screw through the chassis and into the spacers at holes AP, AR, AS, AT, and AU. If necessary, use pliers to align the spacers with the chassis holes. Leave at least 1/16" between the under side of the screw heads and the chassis.

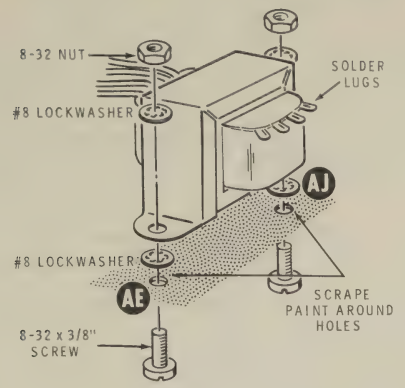
( ) Tighten snugly the six spacer mounting screws on the top of the circuit board. If necessary, hold the spacers with pliers while you tighten the screws.



Detail 2-2B



Detail 2-2C



Detail 2-1J

( ) Refer to Detail 2-1J and mount the power transformer at AE and AJ. Scrape the paint around each mounting hole. Position the four solder lugs toward the edge of the chassis. Use 8-32 x 3/8" hardware. Note the lockwashers used.

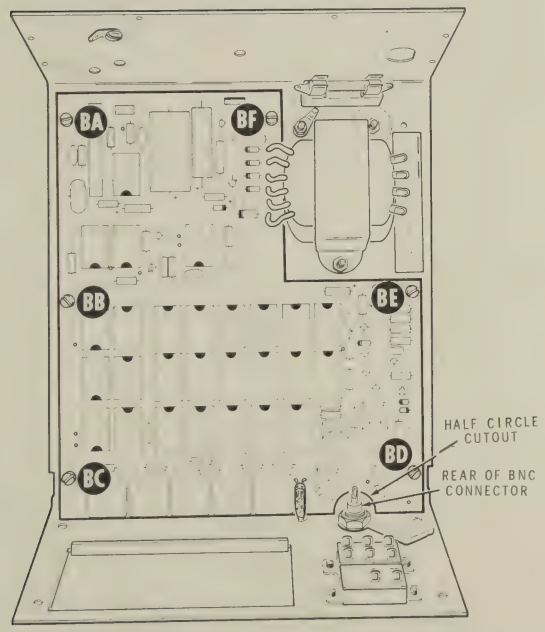
( ) Write in "1/4-Amp, 3AG" or "1/8-Amp, 3AG," as appropriate, in the space above the lines on the fuse label.

( ) Remove the protective covering from the back of the fuse label and press it down against the chassis in the location shown in the Pictorial. Do not cover any holes with the label.

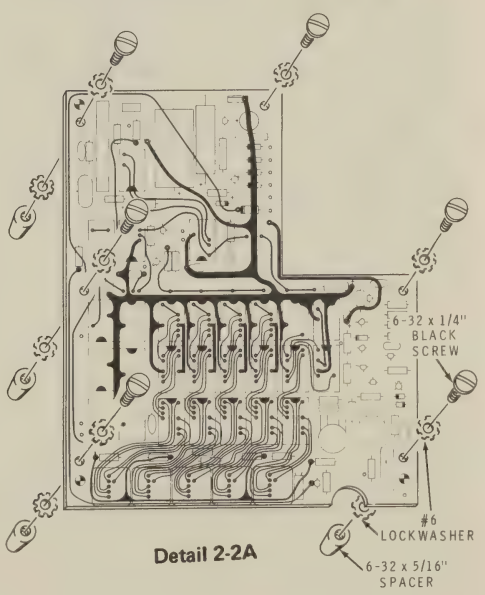
CIRCUIT BOARD MOUNTING

Refer to Pictorial 2-2 for the following steps.

( ) Refer to Detail 2-2A and mount 6-32 x 5/16" spacers on the foil side of the circuit board at BA, BB, BC, BD, BE, and BF. Use a 6-32 x 1/4" black screw and two #6 external tooth lockwashers at each hole. Tighten screw BF. Leave the other screws loose.



PICTORIAL 2-2



Detail 2-2A

CAUTION: In the following step, be sure you place the red transformer lead in the hole marked "red" on the circuit board.

( ) Place the circuit board on edge in the chassis as shown in Detail 2-2B. Then connect the six transformer leads to the appropriate holes in the circuit board (S-6) and cut off the excess lead lengths on the foil side of the board.

( ) Insert the five display tubes into their sockets. Place one hand on the foil side of the circuit board to support the sockets as you apply downward pressure. Make sure the numbers in the tubes face toward the edge of the circuit board and that the tubes are firmly seated in their sockets.

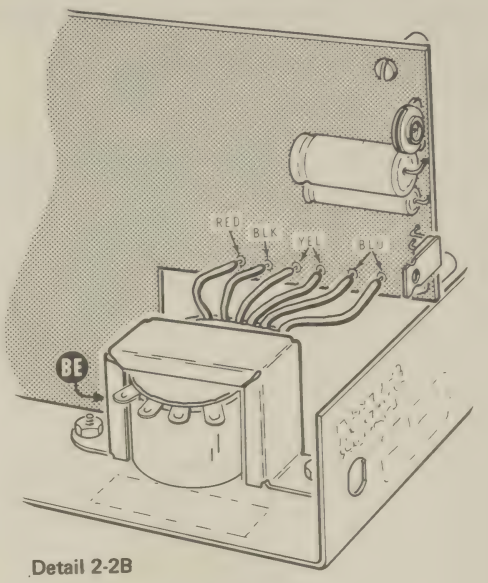
( ) Lower the circuit board to a horizontal position. Then carefully position the circuit board so the half-circle cutout at the front, right-hand corner is under the rear part of the BNC connector. Be sure the tip of the neon lamp enters the hole provided for it.

( ) Refer to Detail 2-2C and install a 6-32 x 1/4" black screw at AG. Leave the screw loose. If the spacer threads are not properly aligned with the circuit board hole, loosen screw BF and adjust the spacer. Then retighten screw BF.

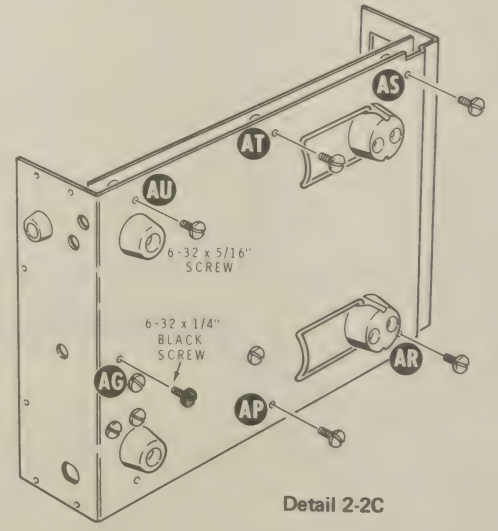
( ) Push the circuit board forward against the back of the front panel. Hold it in this position and tighten the screw at AG.

( ) Install a 6-32 x 5/16" screw through the chassis and into the spacers at holes AP, AR, AS, AT, and AU. If necessary, use pliers to align the spacers with the chassis holes. Leave at least 1/16" between the under side of the screw heads and the chassis.

( ) Tighten snugly the six spacer mounting screws on the top of the circuit board. If necessary, hold the spacers with pliers while you tighten the screws.



Detail 2-2B



Detail 2-2C

CAUTION: In the following step, be sure you place the red transformer lead in the hole marked "red" on the circuit board.

( ) Place the circuit board on edge in the chassis as shown in Detail 2-2B. Then connect the six transformer leads to the appropriate holes in the circuit board (S-6) and cut off the excess lead lengths on the foil side of the board.

( ) Insert the five display tubes into their sockets. Place one hand on the foil side of the circuit board to support the sockets as you apply downward pressure. Make sure the numbers in the tubes face toward the edge of the circuit board and that the tubes are firmly seated in their sockets.

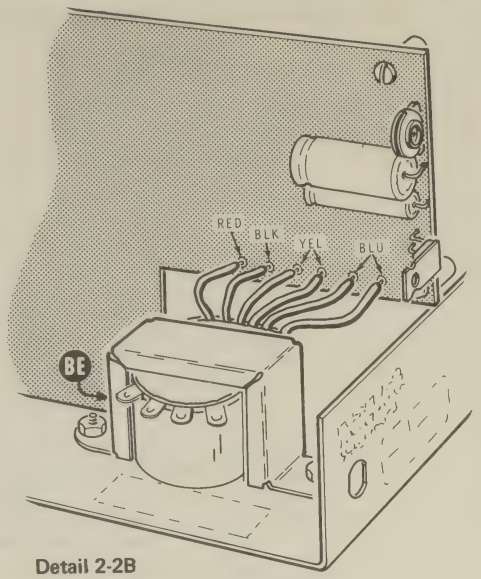
( ) Lower the circuit board to a horizontal position. Then carefully position the circuit board so the half-circle cutout at the front, right-hand corner is under the rear part of the BNC connector. Be sure the tip of the neon lamp enters the hole provided for it.

( ) Refer to Detail 2-2C and install a 6-32 x 1/4" black screw at AG. Leave the screw loose. If the spacer threads are not properly aligned with the circuit board hole, loosen screw BF and adjust the spacer. Then retighten screw BF.

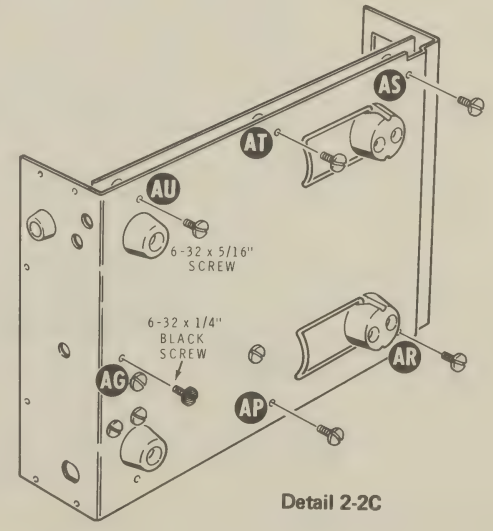
( ) Push the circuit board forward against the back of the front panel. Hold it in this position and tighten the screw at AG.

( ) Install a 6-32 x 5/16" screw through the chassis and into the spacers at holes AP, AR, AS, AT, and AU. If necessary, use pliers to align the spacers with the chassis holes. Leave at least 1/16" between the under side of the screw heads and the chassis.

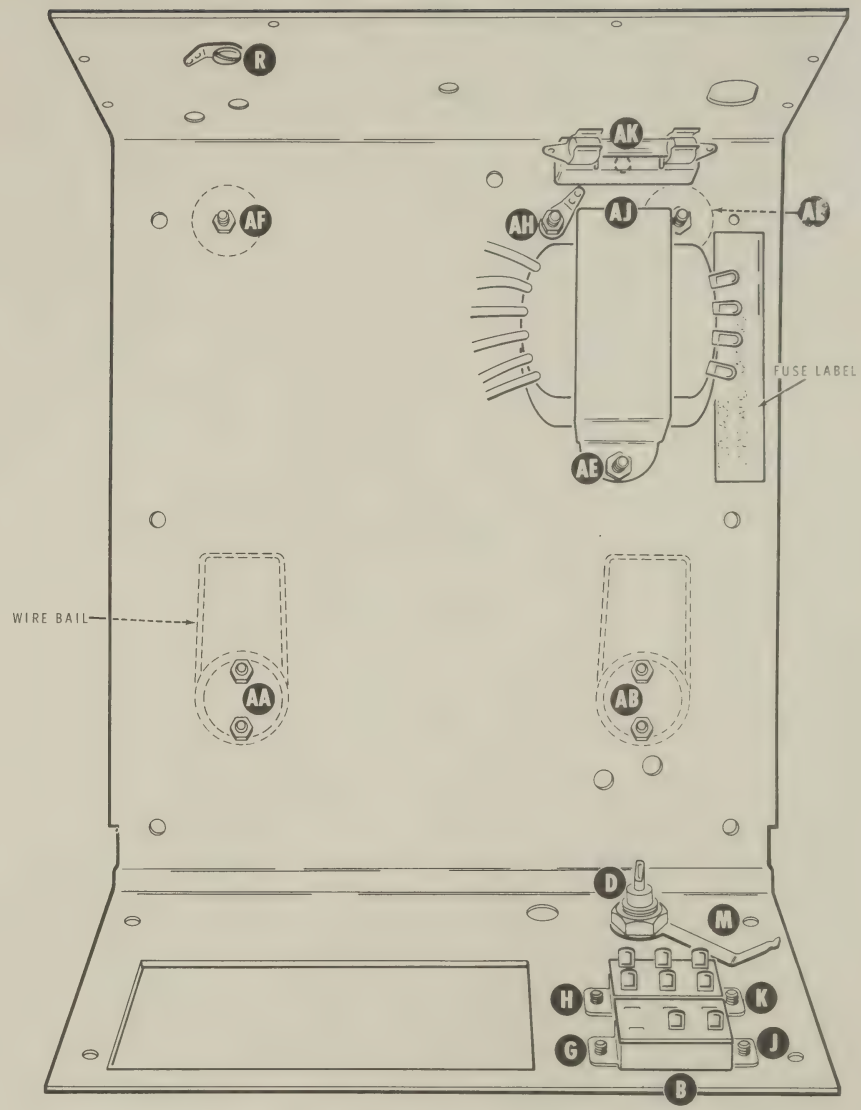
( ) Tighten snugly the six spacer mounting screws on the top of the circuit board. If necessary, hold the spacers with pliers while you tighten the screws.



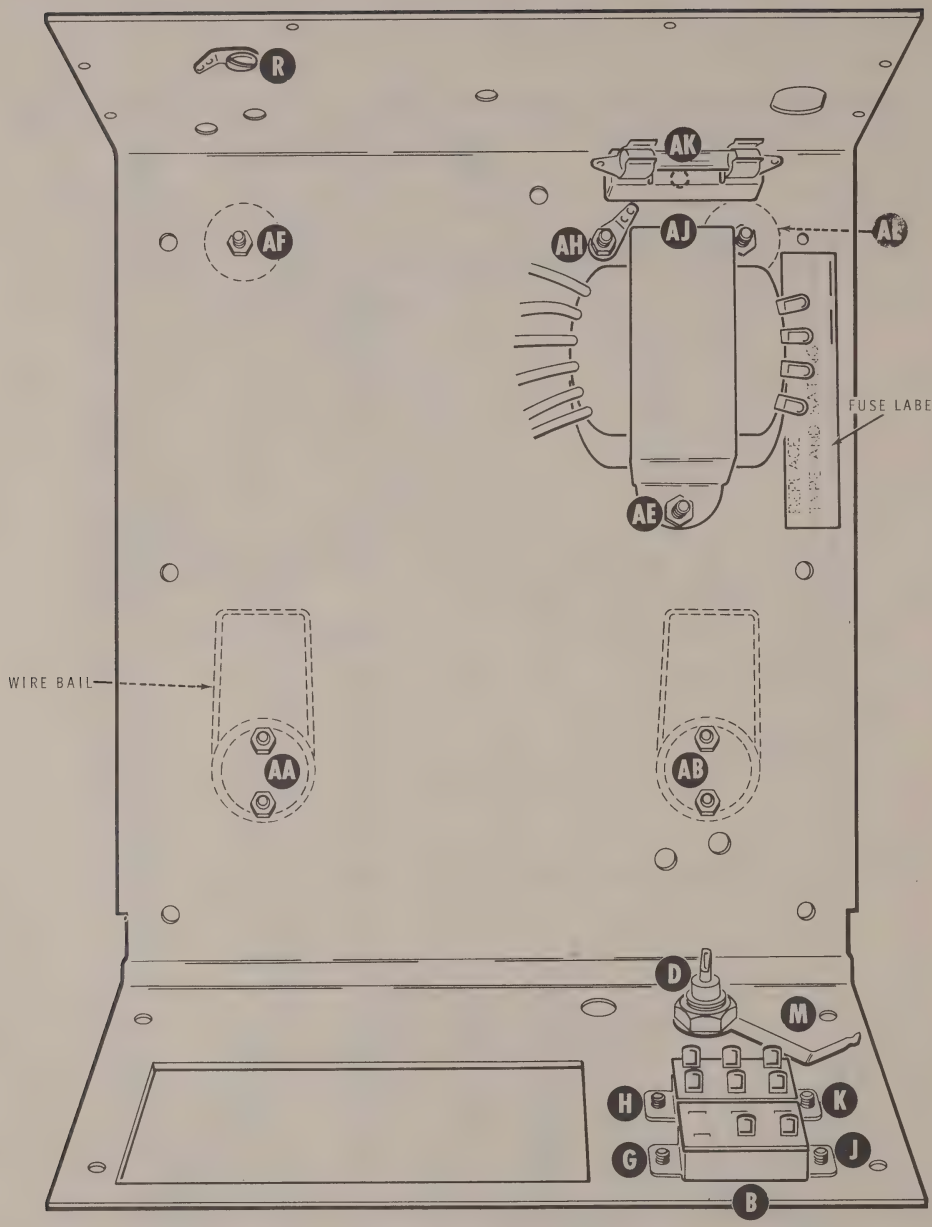
Detail 2-2B



Detail 2-2C



PICTORIAL 2-1



PICTORIAL 2-1

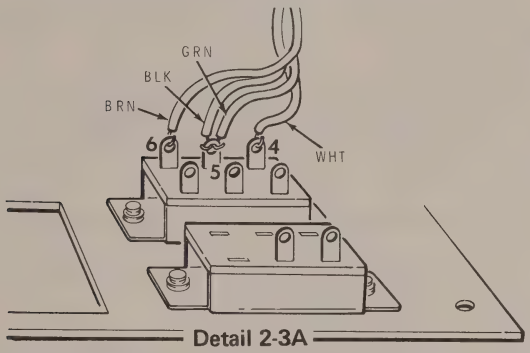
Refer to Pictorial 2-3 for the following steps.

( ) Connect the black wire coming from K on the circuit board to the solder lug at R (S-1).

( ) Connect the white wire coming from J on the circuit board to the BNC connector (S-1). Push the excess wire down against the circuit board.

( ) Connect the violet wire coming from GND on the circuit board to the control solder lug coming from the BNC connector (S-1).

( ) Form the remaining wires from the circuit board into a loosely twisted cable as shown in the Pictorial.



Detail 2-3A

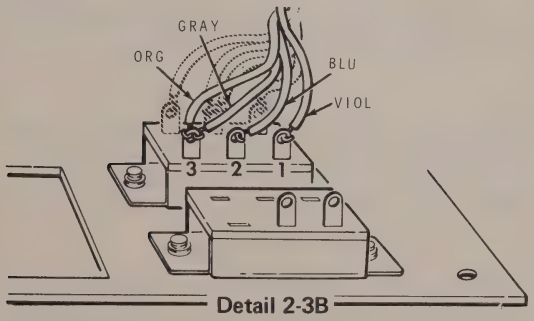
Refer to Detail 2-3A and connect the cabled wires to the DPDT slide switch as follows:

( ) Brown wire to lug 6 (S-1).

( ) Green wire and black wire to lug 5 (S-2).

( ) White wire to lug 4 (S-1).

Refer to Detail 2-3B and complete the switch wiring as follows:



Detail 2-3B

( ) Orange wire and gray wire to lug 3 (S-2).

( ) Blue wire to lug 2 (S-1).

( ) Violet wire to lug 1 (S-1).

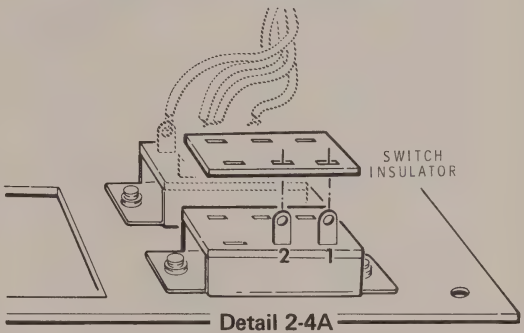
( ) Inspect the wires and make sure none of them touch an IC. The cable should clear the circuit board by approximately 1-1/2 inches.

( ) Cut the foam rubber strip to 4".

( ) Refer to the Pictorial 2-3. First, remove and discard the paper protective strip from the foam rubber. Then press the adhesive side of the foam rubber strip down against the lower edge of opening A in the front chassis lip as shown in the inset drawing.

Refer to Pictorial 2-4 (fold-out from Page 22) for the following steps.

( ) Prepare a 6-1/2" and a 9" length of red wire.



Detail 2-4A

( ) Refer to Detail 2-4A and place the switch insulator over the two lugs of the SPST slide switch. Four slots in this insulator are unused.

NOTE: When you connect the two red wires in the following steps, push the bare end through the solder lug and then wrap it around the lug to make a secure mechanical connection before you solder the wire.

( ) Connect one end of either of the red wires to lug 2 of the SPST switch (S-1).

( ) Connect one end of the remaining red wire to switch lug 1 (S-1).

( ) Twist the red wires loosely together and connect the free end of the shorter red wire to lug 4 of the power transformer (NS).

( ) Connect the free end of the longer red wire to lug 2 of the fuse block (S-1).

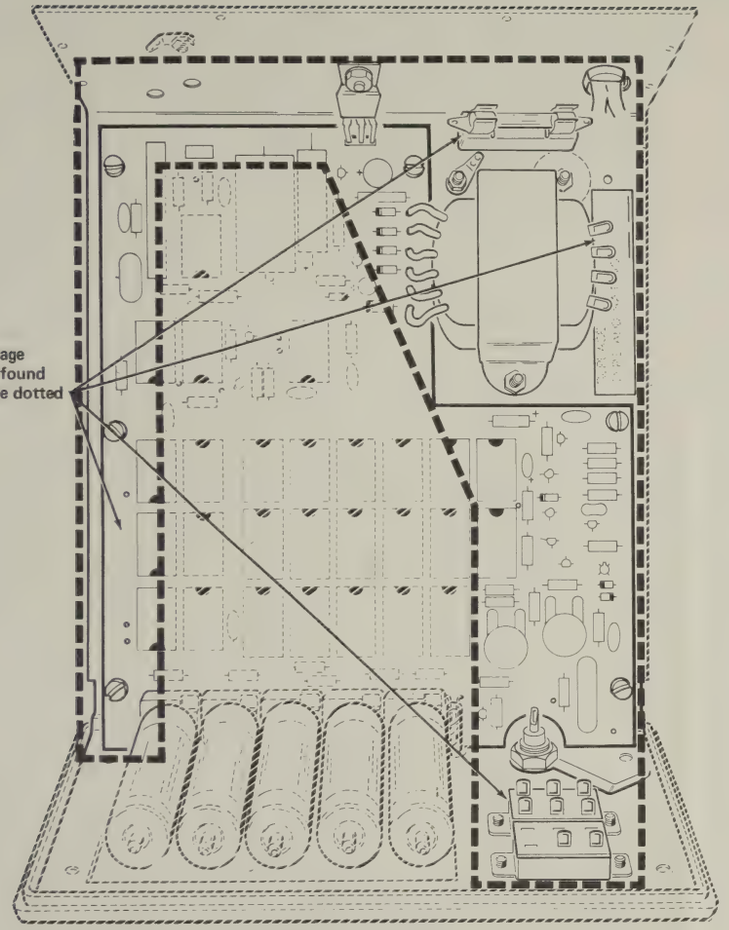
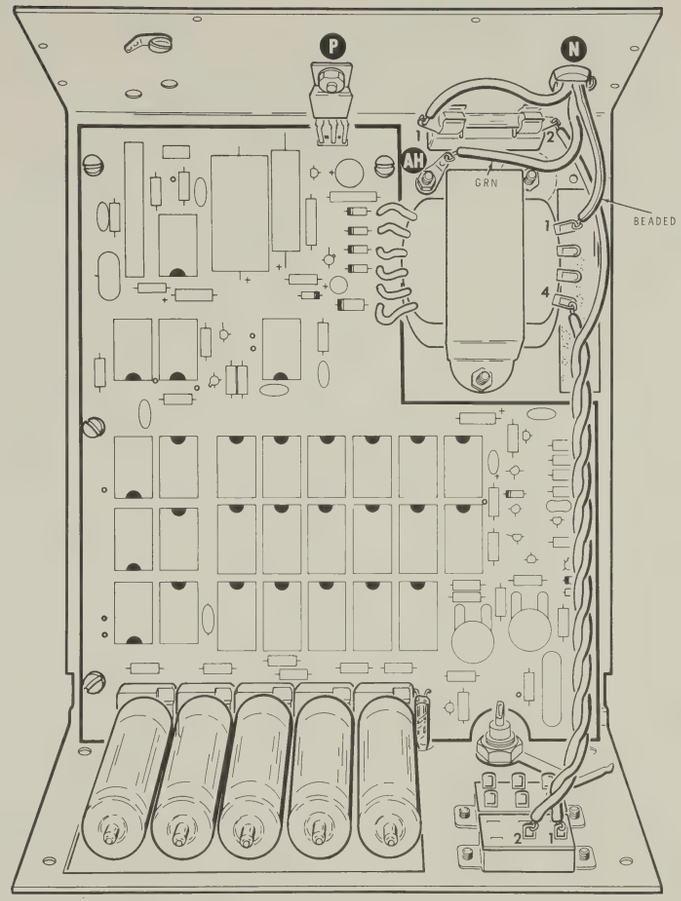
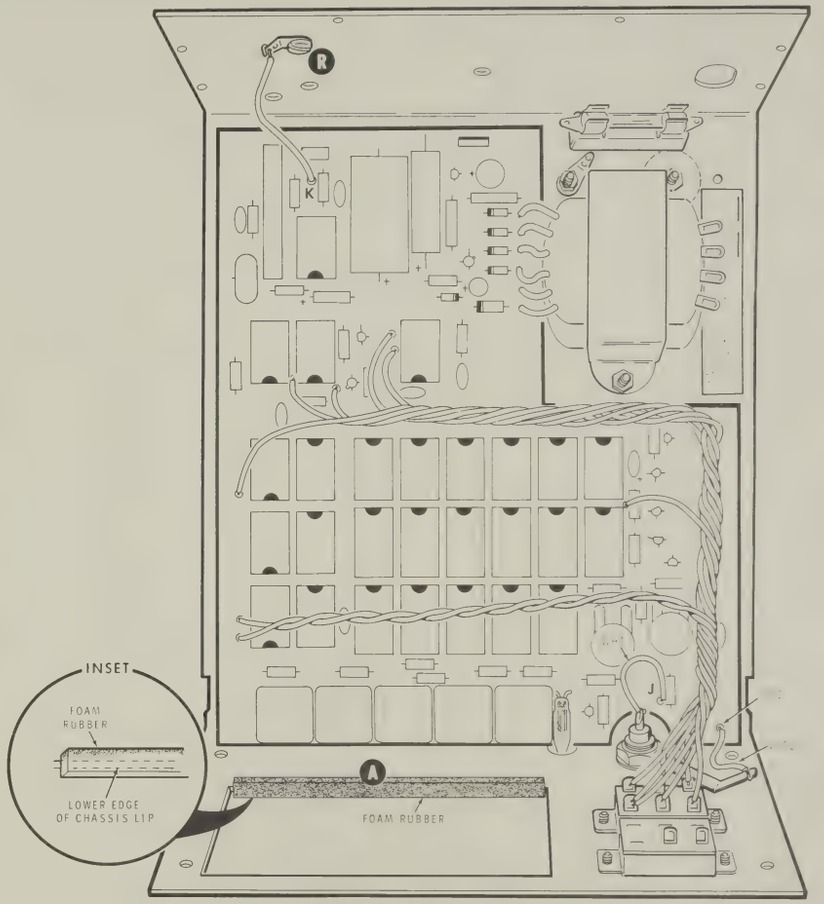


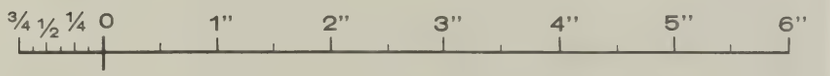
Figure 2-3



PICTORIAL 2-4



PICTORIAL 2-3



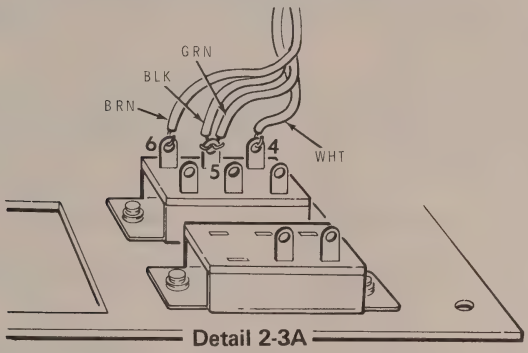
Refer to Pictorial 2-3 for the following steps.

( ) Connect the black wire coming from K on the circuit board to the solder lug at R (S-1).

( ) Connect the white wire coming from J on the circuit board to the BNC connector (S-1). Push the excess wire down against the circuit board.

( ) Connect the violet wire coming from GND on the circuit board to the control solder lug coming from the BNC connector (S-1).

( ) Form the remaining wires from the circuit board into a loosely twisted cable as shown in the Pictorial.



Detail 2-3A

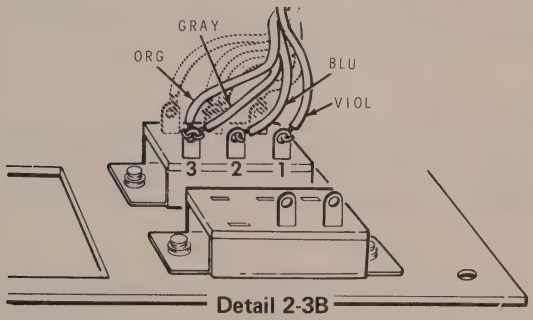
Refer to Detail 2-3A and connect the cabled wires to the DPDT slide switch as follows:

( ) Brown wire to lug 6 (S-1).

( ) Green wire and black wire to lug 5 (S-2).

( ) White wire to lug 4 (S-1).

Refer to Detail 2-3B and complete the switch wiring as follows:



Detail 2-3B

( ) Orange wire and gray wire to lug 3 (S-2).

( ) Blue wire to lug 2 (S-1).

( ) Violet wire to lug 1 (S-1).

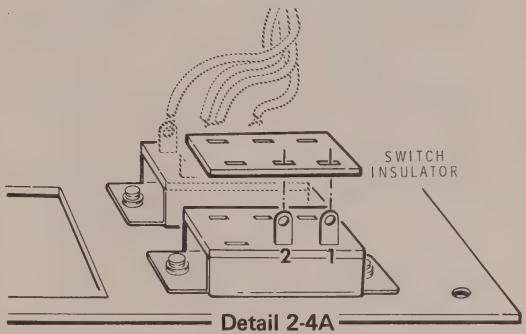
( ) Inspect the wires and make sure none of them touch an IC. The cable should clear the circuit board by approximately 1-1/2 inches.

( ) Cut the foam rubber strip to 4".

( ) Refer to the Pictorial 2-3. First, remove and discard the paper protective strip from the foam rubber. Then press the adhesive side of the foam rubber strip down against the lower edge of opening A in the front chassis lip as shown in the inset drawing.

Refer to Pictorial 2-4 (fold-out from Page 22) for the following steps.

( ) Prepare a 6-1/2" and a 9" length of red wire.



Detail 2-4A

( ) Refer to Detail 2-4A and place the switch insulator over the two lugs of the SPST slide switch. Four slots in this insulator are unused.

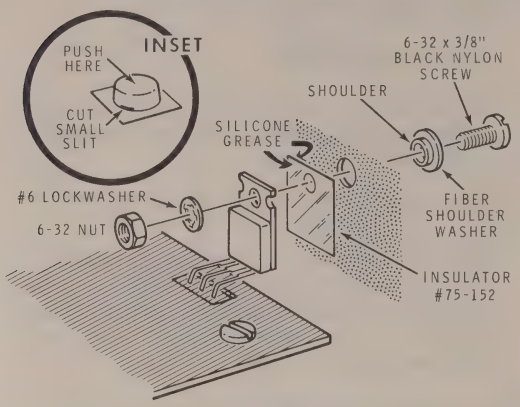
NOTE: When you connect the two red wires in the following steps, push the bare end through the solder lug and then wrap it around the lug to make a secure mechanical connection before you solder the wire.

( ) Connect one end of either of the red wires to lug 2 of the SPST switch (S-1).

( ) Connect one end of the remaining red wire to switch lug 1 (S-1).

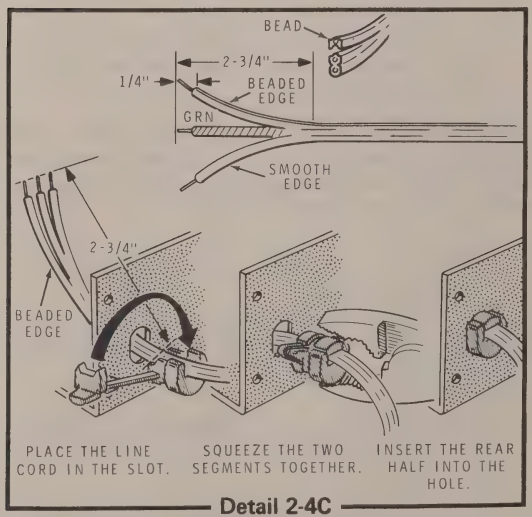
( ) Twist the red wires loosely together and connect the free end of the shorter red wire to lug 4 of the power transformer (NS).

( ) Connect the free end of the longer red wire to lug 2 of the fuse block (S-1).



Detail 2-4B

( ) Refer to Detail 2-4B and secure transistor #417-175 (already mounted on the circuit board) to the rear panel at P as follows: First, open the silicone grease pod as shown in the inset drawing and smear the grease on both sides of the transistor insulator. Then, place the insulator in position on the inside of the rear panel. Make sure the transistor fits flat against the rear panel so the maximum amount of heat will be transferred. Use a fiber shoulder washer, a 6-32 x 3/8" black nylon screw, a #6 lockwasher and a 6-32 nut and mount the transistor as shown. DO NOT overtighten the nut and damage the threads of the nylon screw. Make sure the insulator is properly aligned with the back of the transistor.



Detail 2-4C

Refer to Detail 2-4C for the following steps:

( ) Separate the line cord conductors for a distance of 2-3/4" and, if not already done, remove 1/4" of insulation from the end of each wire. At the end of each conductor, twist the fine strands of wire tightly together and melt a small amount of solder on each end.

( ) Place the strain relief on the line cord 2-3/4" from the end. Then insert the free end of the line cord into hole N from the outside of the rear panel with the beaded wire positioned as shown. Use pliers to compress the strain relief and insert it into hole N.

Refer to Pictorial 2-4 and connect the line cord conductors as follows:

NOTE: When you connect the three line cord wires in the following steps, push the bare end through the solder lug and then wrap it around the lug to make a secure mechanical connection.

( ) Connect the green wire to the solder lug at AH (S-1).

( ) Connect the line cord conductor with the smooth edge to lug 1 of the fuse block (S-1).

( ) Connect the line cord conductor with the beaded edge to lug 1 of the transformer (NS).

TRANSFORMER PRIMARY WIRING

This Frequency Counter can be wired to operate from either 120 VAC or 240 VAC, 50/60 Hz, line voltage. Therefore, two sets of steps are given for the wiring of the power transformer. Follow only the set of steps that agrees with the line voltage in your area.

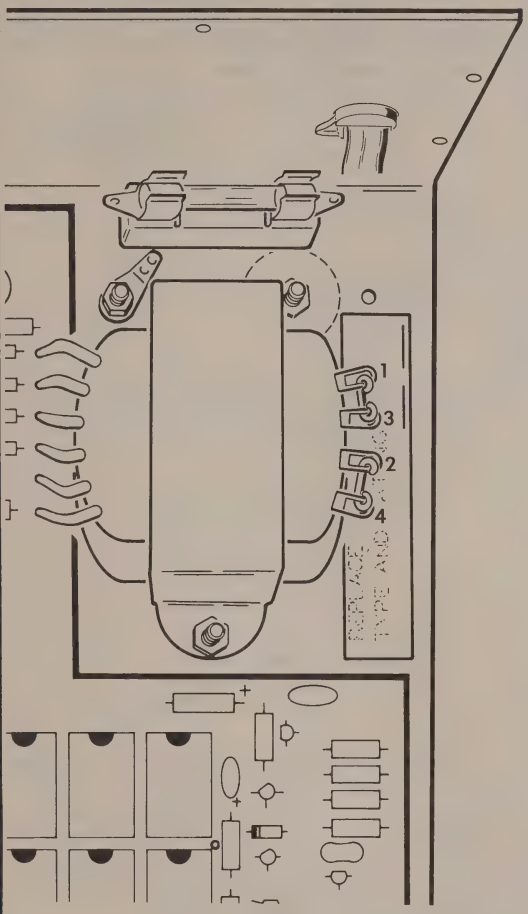
All wires connected to lugs 1, 2, 3, and 4 of the power transformer must be wrapped around the solder lugs to form a secure mechanical connection before soldering.

In the following steps, prepare the required small bare wires by removing the insulation from 3/4" lengths of the wire remaining from the circuit board wiring. Then discard the pieces of wire not used.

120 VAC Wiring

( ) Connect a 3/4" small bare wire from lug 1 (S-2) to lug 3 (S-1) of the power transformer.

( ) Connect a 3/4" small bare wire from lug 2 (S-1) to lug 4 (S-2) of the power transformer.

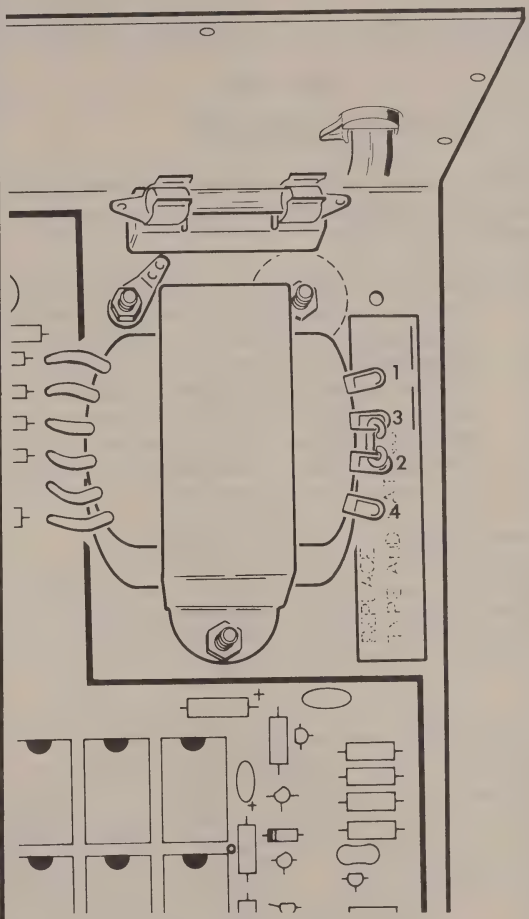


Detail 2-4D

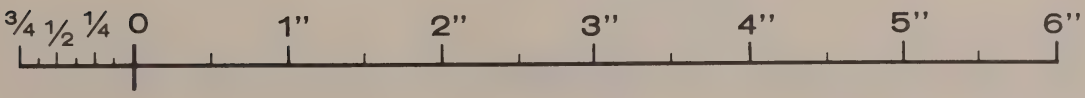
240 VAC Wiring

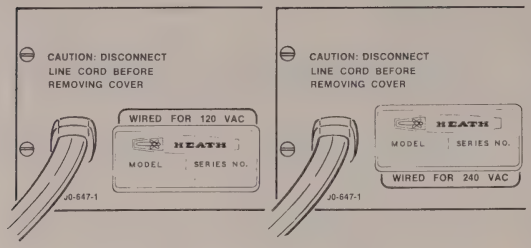
( ) Connect a 3/4" small bare wire from lug 2 (S-1) to lug 3 (S-1) of the power transformer.

( ) Solder the wires at lugs 1 and 4 of the power transformer.



Detail 2-4E





Detail 2-4F

PANEL AND LABEL MOUNTING

NOTE: The blue and white label shows the model number of your kit. Refer to these numbers in any communications with the Heath Company.

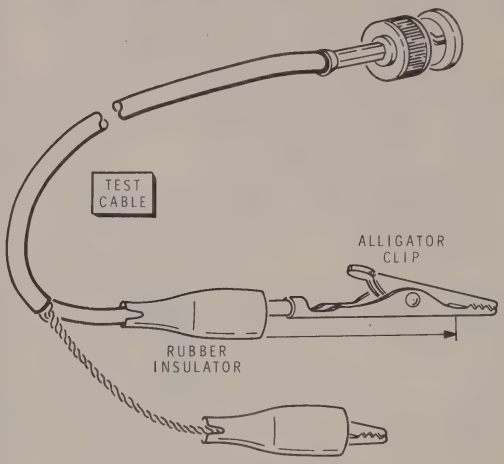
( ) Refer to Detail 2-4F and install the blue and white identification label. Position the label over the outline on the rear panel so it exposes the correct wiring information and covers the incorrect information. Carefully peel away the backing paper. Then press the label into position. You will avoid smearing the numbers on the label if you will put the piece of waxed backing paper on top of the label and then rub on it instead of directly on the label.

Refer to Pictorial 2-5 for the following steps.

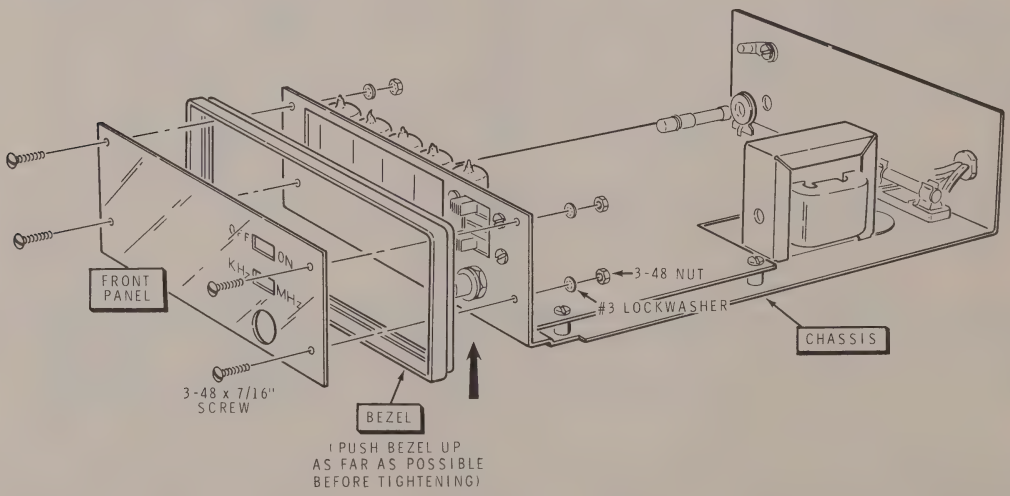
NOTE: The beveled side of the bezel is toward the front panel. Disregard the cutout in one corner of the bezel.

( ) Fit the front panel and bezel to the chassis. Adjust the two slide switches so they do not rub against the front panel when operated. Then remove the panel and bezel and tighten the switch mounting screws.

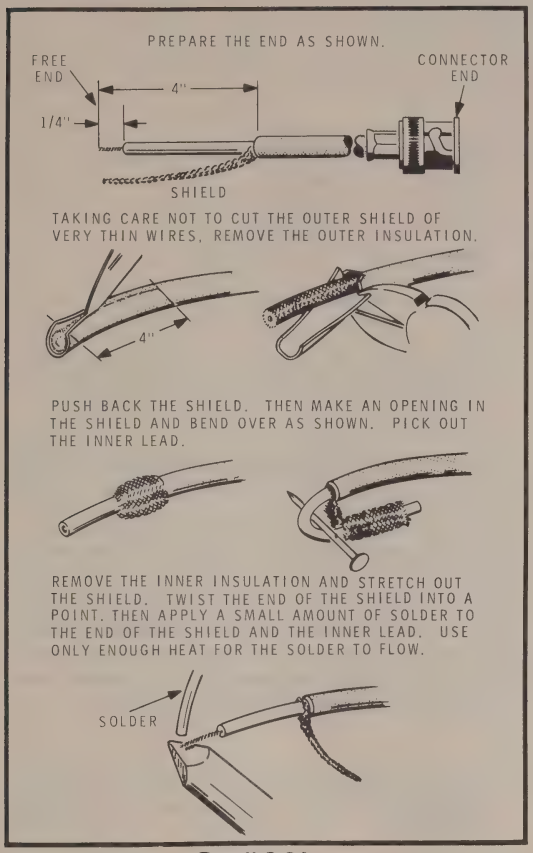
( ) Mount the front panel and the bezel on the front chassis lip. Use 3-48 x 7/16" hardware. Do not overtighen these screws as the threads or the plastic panel can be damaged. Push the bottom of the bezel up as far as possible against the bottom of the chassis before tightening the hardware.



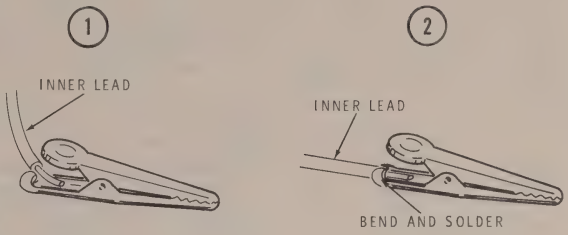
PICTORIAL 2-6



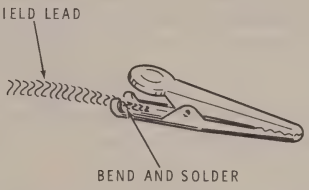
PICTORIAL 2-5


PREPARE THE END AS SHOWN.
FREE END
CONNECTOR END
4"
1/4"
SHIELD
TAKING CARE NOT TO CUT THE OUTER SHIELD OF VERY THIN WIRES, REMOVE THE OUTER INSULATION.
4"
PUSH BACK THE SHIELD. THEN MAKE AN OPENING IN THE SHIELD AND BEND OVER AS SHOWN. PICK OUT THE INNER LEAD.
REMOVE THE INNER INSULATION AND STRETCH OUT THE SHIELD. TWIST THE END OF THE SHIELD INTO A POINT. THEN APPLY A SMALL AMOUNT OF SOLDER TO THE END OF THE SHIELD AND THE INNER LEAD. USE ONLY ENOUGH HEAT FOR THE SOLDER TO FLOW.
SOLDER

Detail 2-6A



Detail 2-6B



Detail 2-6C

TEST CABLE ASSEMBLY

Refer to Pictorial 2-6 for the following steps.

( ) Refer to Detail 2-6A and prepare the free end of the cable assembly.

( ) Refer to Pictorial 2-6 and push rubber insulators onto the inner lead and the shield lead of the cable.

( ) Refer to Detail 2-6B and install an alligator clip on the inner lead of the cable as shown in parts 1 and 2 of the Detail.

( ) Refer to Detail 2-6C and install an alligator clip on the shield lead of the cable as shown.

( ) Allow the connections to cool. Then push the rubber insulators down over the alligator clips.

This completes the "Test Cable Assembly." Proceed to "Initial Checkout."

INITIAL CHECKOUT

CAUTION

Use extreme care during initial testing and all subsequent maintenance of this Frequency Counter. While this device is designed for maximum safety, never lose respect for the high voltage present in this unit. Protect yourself always against lethal or severe electric shock.

The purpose of the "Initial Checkout" section of the Manual is to make sure your Counter operates properly and will not be damaged as the result of an assembly or wiring error. A transistor or integrated circuit, for example, could be destroyed instantly by a short circuit that causes excessive current.

Refer to Figure 2-1 (fold-out from Page 29) for the location of components mentioned in this section.

( ) Examine all chassis mounted parts to make sure they are properly mounted and connected.

( ) Be sure no bare wires are touching any components or the chassis.

( ) Push the Power switch to the OFF position.

NOTE: If a VTVM or other meter is available, make the following "Resistance Checks" and "Voltage Checks." If a meter is not available, proceed to "Display Checks."

RESISTANCE CHECKS

These resistance checks are to make sure there are no short circuits in any of the three power supply branches. DO NOT plug in the line cord until instructed to do so in the "Voltage Checks" section which follows.

( ) Set your ohmmeter on the RX10 scale (or the next scale higher than RX1).

( ) Connect the common lead of your ohmmeter to the control solder lug on the back of the INPUT connector.

NOTE: The resistances in the following steps are the minimum desired. If the resistance readings are significantly less, the reason (such as a short circuit caused by a solder bridge between foils) must be determined and corrected before proceeding. As some ohmmeters use the "common" lead as the positive lead, try reversing your ohmmeter leads if you do not get the designated resistance readings.

( ) Refer to Figure 2-2 and touch the ohmmeter probe to the foil at point ①. The meter reading should be 30 Ω or more.

( ) Touch the ohmmeter probe to the foil at point ②. The meter reading should be 100 Ω or more.

( ) Touch the ohmmeter probe to the foil at point ③. The meter reading should be 100 kΩ or more.

( ) If the above resistance checks are satisfactory, proceed to the "Voltage Checks" section.

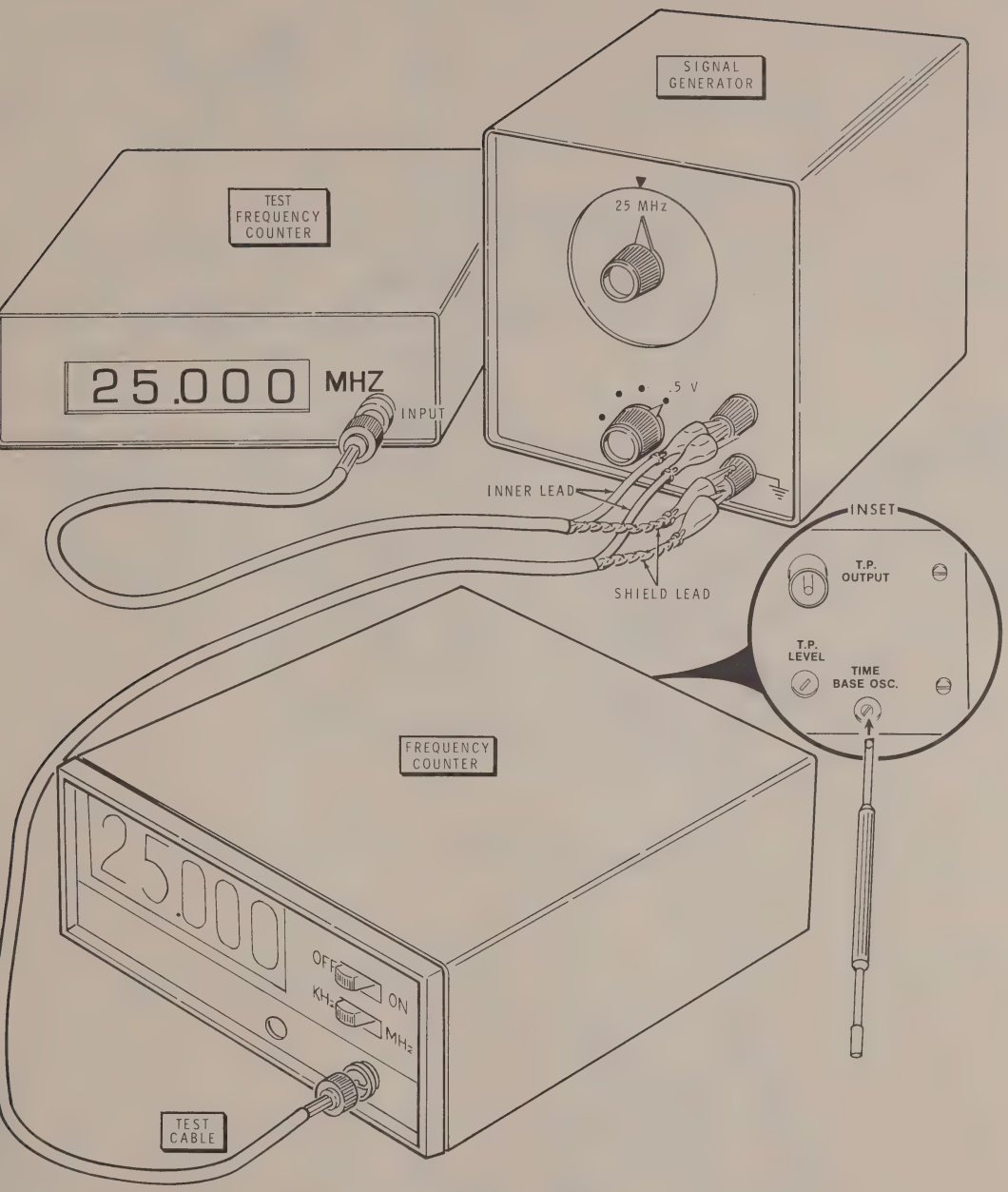

SIGNAL GENERATOR
TEST FREQUENCY COUNTER
25 MHz
25.000 MHZ
INPUT
.5 V
INNER LEAD
SHIELD LEAD
INSET
T.P. OUTPUT
T.P. LEVEL
TIME BASE OSC.
FREQUENCY COUNTER
25.000
OFF
ON
KHz
MHz
TEST CABLE

Figure 3-4.

INITIAL CHECKOUT

CAUTION

Use extreme care during initial testing and all subsequent maintenance of this Frequency Counter. While this device is designed for maximum safety, never lose respect for the high voltage present in this unit. Protect yourself always against lethal or severe electric shock.

The purpose of the "Initial Checkout" section of the Manual is to make sure your Counter operates properly and will not be damaged as the result of an assembly or wiring error. A transistor or integrated circuit, for example, could be destroyed instantly by a short circuit that causes excessive current.

Refer to Figure 2-1 (fold-out from Page 29) for the location of components mentioned in this section.

( ) Examine all chassis mounted parts to make sure they are properly mounted and connected.

( ) Be sure no bare wires are touching any components or the chassis.

( ) Push the Power switch to the OFF position.

NOTE: If a VTVM or other meter is available, make the following "Resistance Checks" and "Voltage Checks." If a meter is not available, proceed to "Display Checks."

RESISTANCE CHECKS

These resistance checks are to make sure there are no short circuits in any of the three power supply branches. DO NOT plug in the line cord until instructed to do so in the "Voltage Checks" section which follows.

( ) Set your ohmmeter on the RX10 scale (or the next scale higher than RX1).

( ) Connect the common lead of your ohmmeter to the control solder lug on the back of the INPUT connector.

NOTE: The resistances in the following steps are the minimum desired. If the resistance readings are significantly less, the reason (such as a short circuit caused by a solder bridge between foils) must be determined and corrected before proceeding. As some ohmmeters use the "common" lead as the positive lead, try reversing your ohmmeter leads if you do not get the designated resistance readings.

( ) Refer to Figure 2-2 and touch the ohmmeter probe to the foil at point ①. The meter reading should be 30 Ω or more.

( ) Touch the ohmmeter probe to the foil at point ②. The meter reading should be 100 Ω or more.

( ) Touch the ohmmeter probe to the foil at point ③. The meter reading should be 100 kΩ or more.

( ) If the above resistance checks are satisfactory, proceed to the "Voltage Checks" section.

VOLTAGE CHECKS

Use a high input impedance voltmeter to check the voltages in this section.

In the following steps, if the Counter does not operate as described, immediately unplug the line cord and refer to "In Case of Difficulty," on Page 36. Correct the problem before proceeding with the "Initial Checkout."

DANGER: *Whenever the line cord is connected to an AC outlet, dangerous voltages will be present, even when the switch is in the OFF position. Except when an insulated tool is used, do not handle or work on this instrument when the covers are removed until the line cord has been disconnected. Refer to "High Voltage Areas" Figure 2-3.*

( ) Push the Power switch to the OFF position.

( ) Push the RANGE switch to the kHz position.

( ) Plug the line cord into an AC outlet of the proper voltage (120 or 240 VAC).

( ) Connect the common lead of your voltmeter to the control solder lug on the back of the INPUT connector.

( ) Refer to Figure 2-2 and touch the voltmeter probe to the foil at point ①; then push the Power switch to the ON position. If the meter reads between +4-3/4 volts and +5-1/4 volts, the circuit is operating properly. If the meter reads higher than +5-1/4 volts, IMMEDIATELY push the Power switch to OFF, as a higher voltage may destroy the IC's within seconds. Refer to the "In Case of Difficulty" section on Page 36 and clear the problem before proceeding.

( ) Similarly, check the voltage at point ②, which should be within 5% of +15.2 volts.

( ) Check the voltage at point ③, which should be within 10% of +100 volts.

( ) Disconnect the voltmeter.

DISPLAY CHECKS

Refer to Figure 2-1 for the following steps.

( ) With the line cord unplugged and the Power switch OFF, use the white alignment tool and turn both the INPUT COARSE and the INPUT FINE controls to midrange (the center of their rotation).

( ) Push the Range switch to the kHz position.

( ) Connect the line cord and push the Power switch to ON. The five display tubes should light and all tubes should then reset to zero within approximately two seconds.

( ) Push the Range switch to the MHz position. The display tubes should all remain at zero.

( ) Push the Power switch to OFF and unplug the line cord.

( ) Connect the test cable to the INPUT connector as shown.

( ) Connect the inner lead of the test cable to the TP OUTPUT (test point) on the rear chassis lip as shown in the inset drawing. The shield lead is not connected.

( ) Refer to the inset drawing of Figure 2-2 and use the white alignment tool to rotate the TP LEVEL control fully clockwise.

( ) Plug in the line cord, push the Power switch to ON and push the Range switch to MHz. If the frequency reading is NOT 01.000 MHz, slowly turn the INPUT COARSE control until the display tubes indicate approximately 1.000 MHz.

NOTE: If your Counter performs as described, disconnect both the line cord and the input cable and proceed to "Final Assembly." If it does not perform as described, or if the OVER (overrange) lamp is lit, disconnect the line cord and refer to the "In Case of Difficulty" section on Page 36. Correct the problem before proceeding.

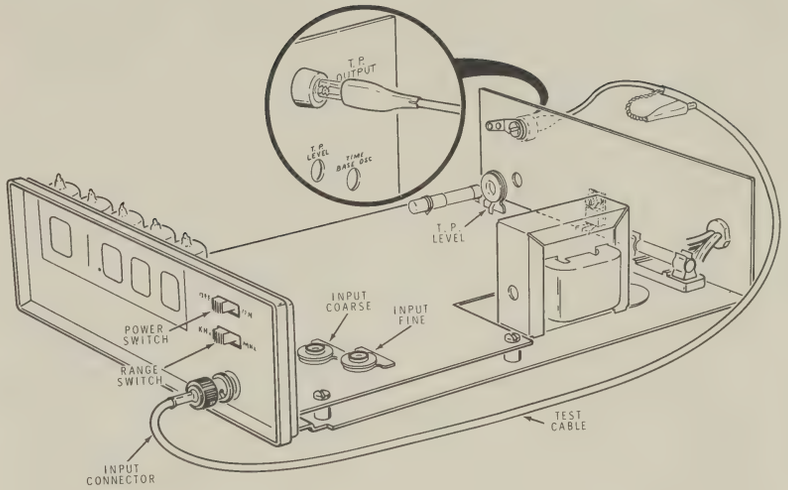


Figure 2-1

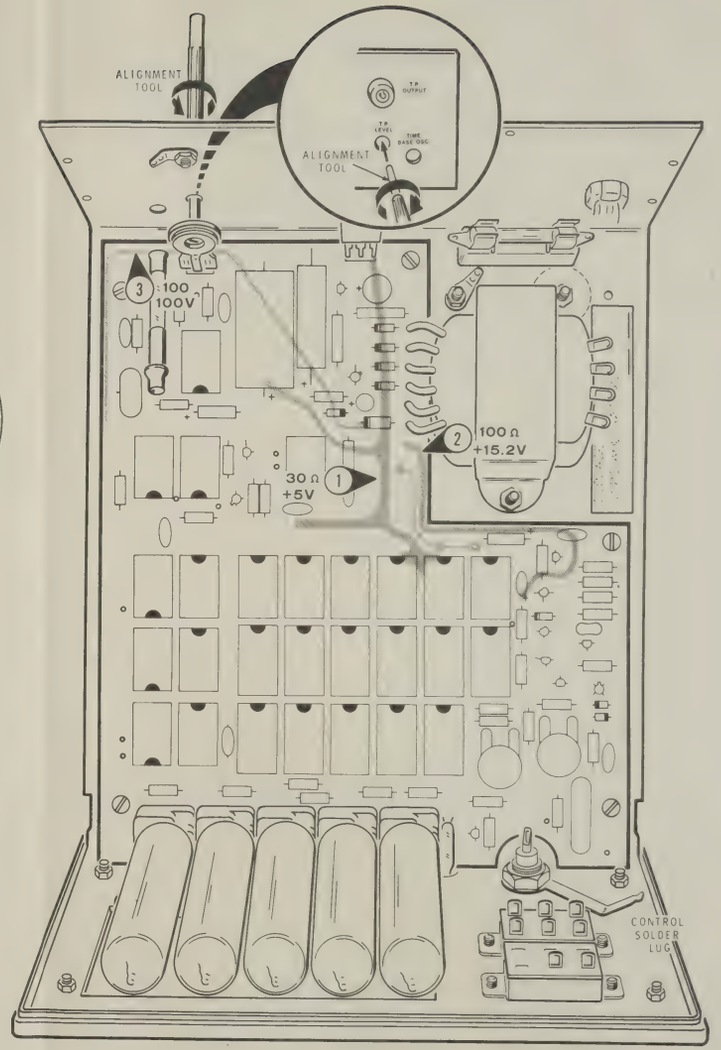
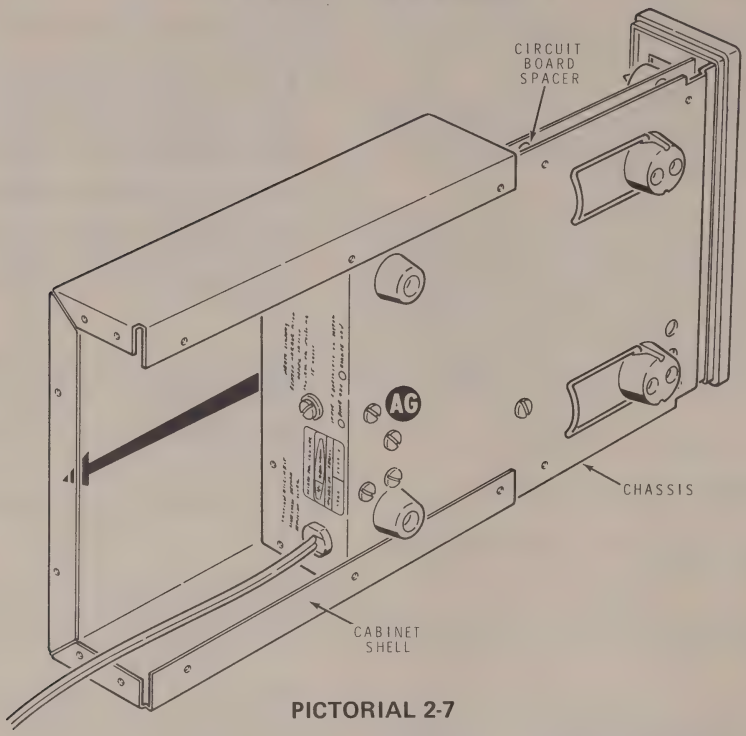
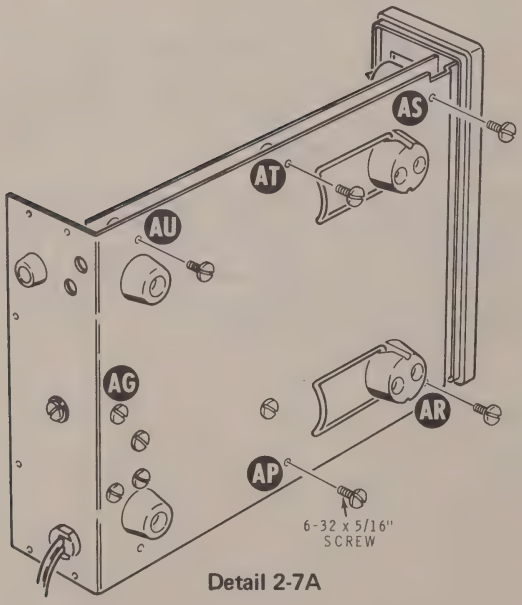


Figure 2-2

FINAL ASSEMBLY



PICTORIAL 2-7



Detail 2-7A

Refer to Pictorial 2-7 for the following steps.

( ) Refer to Detail 2-7A and remove the five 6-32 x 5/16" screws which hold the circuit board to the chassis at AP, AR, AS, AT, and AU. Do not remove the screw at AG.

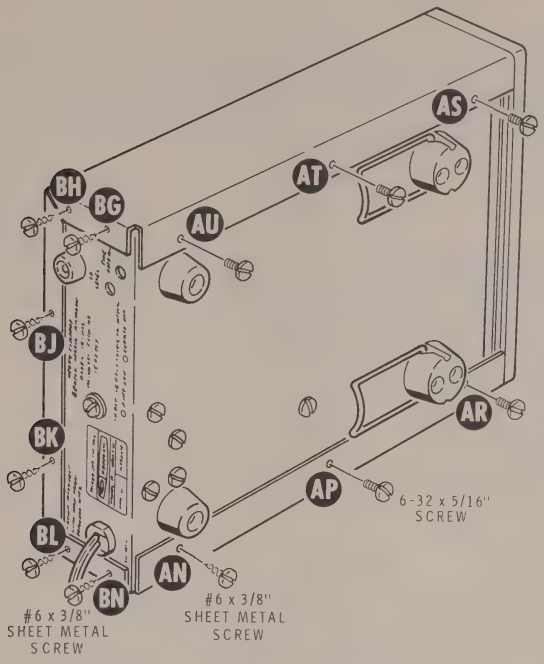
( ) Refer to Pictorial 2-7 and slide the chassis into the cabinet shell.

( ) Install six #6 x 3/8" sheet metal screws through the cabinet shell and into the rear panel at BG, BH, BJ, BK, BL, and BN.

( ) Refer to Detail 2-7B and install 6-32 x 5/16" screws through the cabinet shell, chassis, and into the circuit board spacers at AP, AR, AS, AT, and AU.

( ) Install a #6 x 3/8" sheet metal screw through the cabinet shell and into the chassis at AN.

This completes the assembly of your Frequency Counter. Proceed to the "Calibration" section.



Detail 2-7B

CALIBRATION

This section of the Manual contains two calibration procedures. If you have access to a reliable frequency counter and/or an accurate frequency generator, proceed to the "With Instruments" procedures on Page 34. If these instruments are not available, proceed with the following "Without Instruments" procedure.

The accuracy of your Counter depends to a great extent upon the care and accuracy that you exercise in performing the following steps. If at any time you do not obtain the results called for in a step, refer to the "In Case of Difficulty" section on Page 36 to correct the problem.

Without Instruments

IMPORTANT: Most communications receivers and standard (AM) broadcast receivers, especially those with a built-in antenna coil, have sufficient sensitivity to produce the audible difference frequency called for in the following steps with the cabinet shell remaining on your Counter. However, if you are unable to hear the difference frequency, try another receiver and/or remove the cabinet shell from your Counter before you assume there is a difficulty.

( ) Turn the Counter on and allow it to warm up for 30 minutes. This is MOST IMPORTANT for an accurate calibration.

( ) Push the RANGE switch to the MHz position.

( ) Remove the test cable from the counter INPUT connector, if it is not already done.

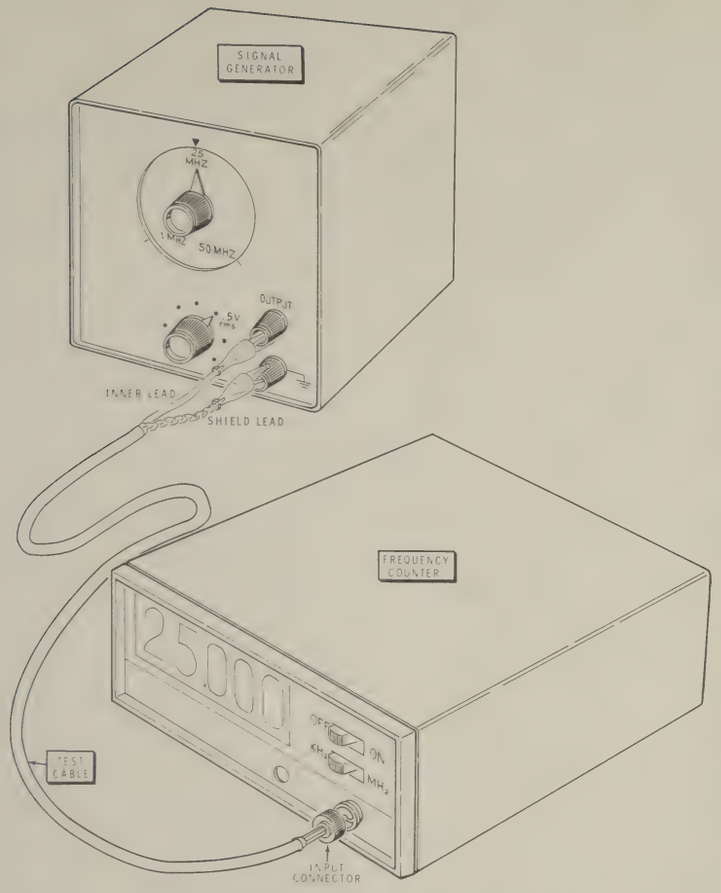


Figure 3-3

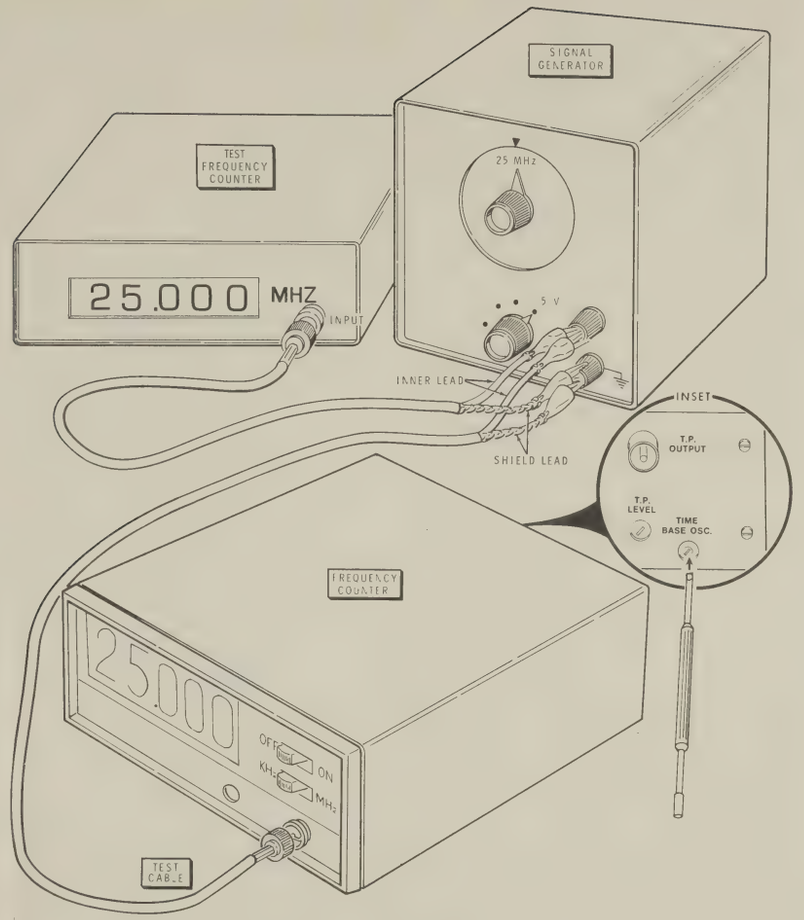
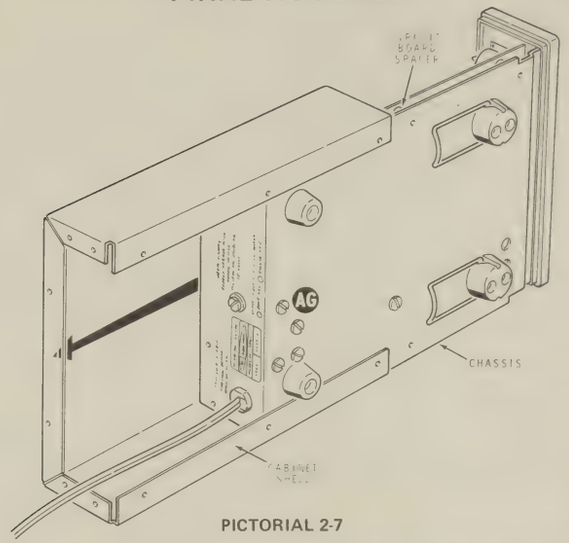
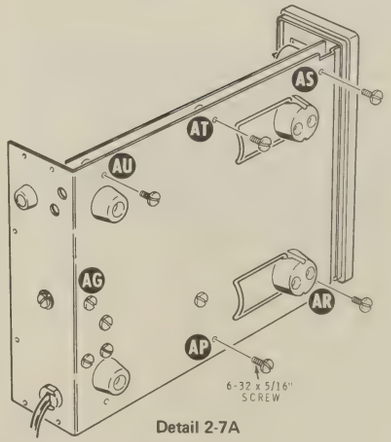


Figure 3-4

FINAL ASSEMBLY



PICTORIAL 2-7



Detail 2-7A

Refer to Pictorial 2-7 for the following steps.

( ) Refer to Detail 2-7A and remove the five 6-32 x 5/16" screws which hold the circuit board to the chassis at AP, AR, AS, AT, and AU. Do not remove the screw at AG.

( ) Refer to Pictorial 2-7 and slide the chassis into the cabinet shell.

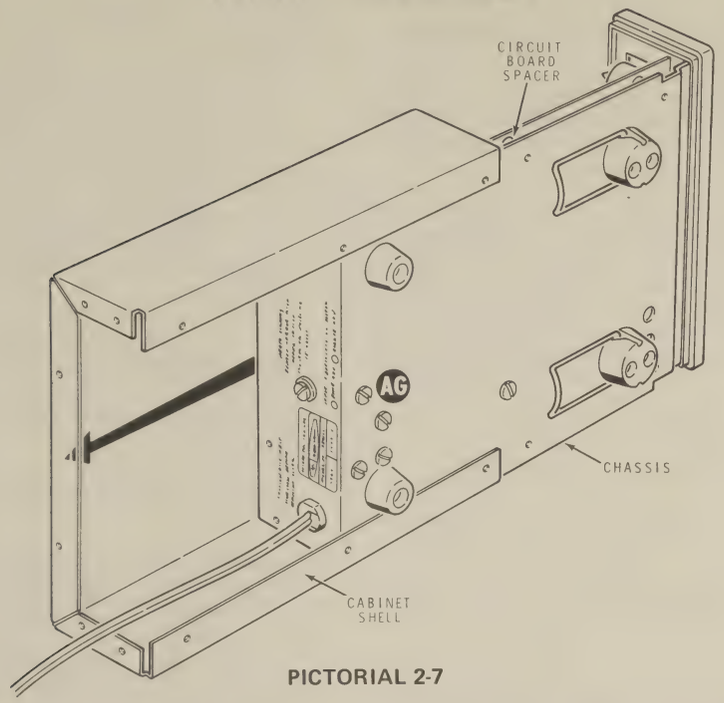
( ) Install six #6 x 3/8" sheet metal screws through the cabinet shell and into the rear panel at BG, BH, BJ, BK, BL, and BN.

( ) Refer to Detail 2-7B and install 6-32 x 5/16" screws through the cabinet shell, chassis, and into the circuit board spacers at AP, AR, AS, AT, and AU.

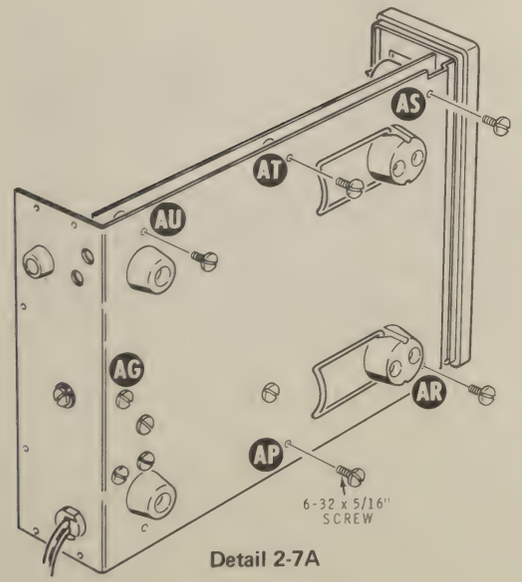
( ) Install a #6 x 3/8" sheet metal screw through the cabinet shell and into the chassis at AN.

This completes the assembly of your Frequency Counter. Proceed to the "Calibration" section.

FINAL ASSEMBLY



PICTORIAL 2-7



Detail 2-7A

Refer to Pictorial 2-7 for the following steps.

( ) Refer to Detail 2-7A and remove the five 6-32 x 5/16" screws which hold the circuit board to the chassis at AP, AR, AS, AT, and AU. Do not remove the screw at AG.

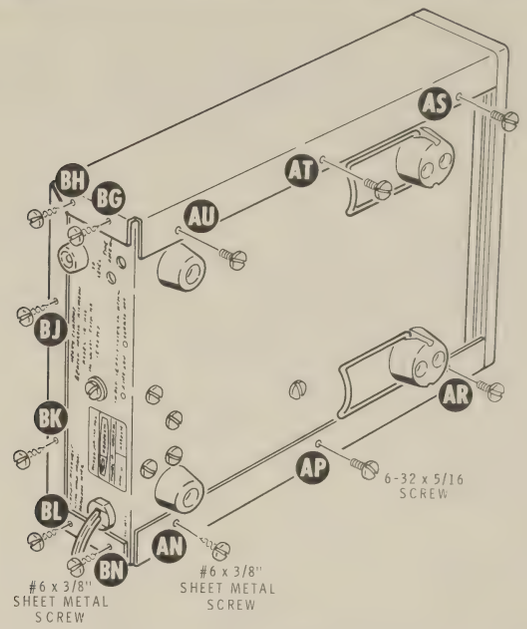
( ) Refer to Pictorial 2-7 and slide the chassis into the cabinet shell.

( ) Install six #6 x 3/8" sheet metal screws through the cabinet shell and into the rear panel at BG, BH, BJ, BK, BL, and BN.

( ) Refer to Detail 2-7B and install 6-32 x 5/16" screws through the cabinet shell, chassis, and into the circuit board spacers at AP, AR, AS, AT, and AU.

( ) Install a #6 x 3/8" sheet metal screw through the cabinet shell and into the chassis at AN.

This completes the assembly of your Frequency Counter. Proceed to the "Calibration" section.



Detail 2-7B

CALIBRATION

This section of the Manual contains two calibration procedures. If you have access to a reliable frequency counter and/or an accurate frequency generator, proceed to the "With Instruments" procedures on Page 34. If these instruments are not available, proceed with the following "Without Instruments" procedure.

The accuracy of your Counter depends to a great extent upon the care and accuracy that you exercise in performing the following steps. If at any time you do not obtain the results called for in a step, refer to the "In Case of Difficulty" section on Page 36 to correct the problem.

Without Instruments

IMPORTANT: Most communications receivers and standard (AM) broadcast receivers, especially those with a built-in antenna coil, have sufficient sensitivity to produce the audible difference frequency called for in the following steps with the cabinet shell remaining on your Counter. However, if you are unable to hear the difference frequency, try another receiver and/or remove the cabinet shell from your Counter before you assume there is a difficulty.

( ) Turn the Counter on and allow it to warm up for 30 minutes. This is MOST IMPORTANT for an accurate calibration.

( ) Push the RANGE switch to the MHz position.

( ) Remove the test cable from the counter INPUT connector, if it is not already done.

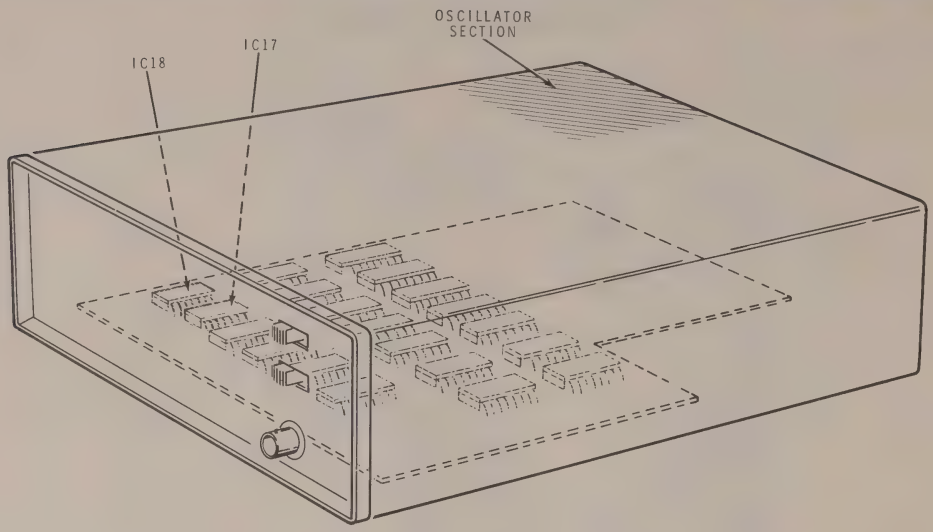


Figure 3-1

CLOCK OSCILLATOR

Your Counter will be calibrated by using a radio receiver to compare the frequency of the Counter's 1 MHz clock oscillator with an accurate radio frequency. Signals from a radio station and from your Counter will be received simultaneously, and adjustments will be made as described later. The radio station signal can be received by two different methods. Select one of the methods and calibrate the oscillator.

1. If you have a general coverage communications receiver, use its AM mode. For best accuracy, tune it to the highest WWV station frequency (25, 20, 15, 10, or 5 MHz) receivable at a satisfactory volume in your area. Temporarily connect an insulated, unshielded wire to the receiver antenna connection and lay the wire over the oscillator section of your Counter in the area shown in Figure 3-1.

A steady tone should be heard which will probably pulsate from one to several times each second. If you do not hear the tone, remove the cabinet shell and place the insulated wire near IC21. This should make the signal audible.

2. Broadcast AM radios can be used by tuning in a station of medium volume and connecting a temporary additional antenna and laying it over the oscillator section of the Counter at the location shown in Figure 3-1. A portable AM broadcast radio can also be used by holding it so its antenna is close to the Counter oscillator section. If the tone of the Counter oscillator is not heard, remove the Counter cabinet shell and bring the temporary antenna wire close to IC17 and IC18, or hold the portable radio within about 2" of these IC's.

( ) When the pulsating tone is heard, refer to Figure 3-2 and insert the screwdriver end of the white alignment tool into hole TIME BASE OSC on the rear chassis lip and into the piston trimmer capacitor.

( ) Engage the end of the alignment tool in the screw slot of the trimmer. Then turn the screw in the direction which reduces the frequency of the pulsations. When the pulsations cease and a steady tone is heard, the adjustment is correct. Carefully withdraw the alignment tool.

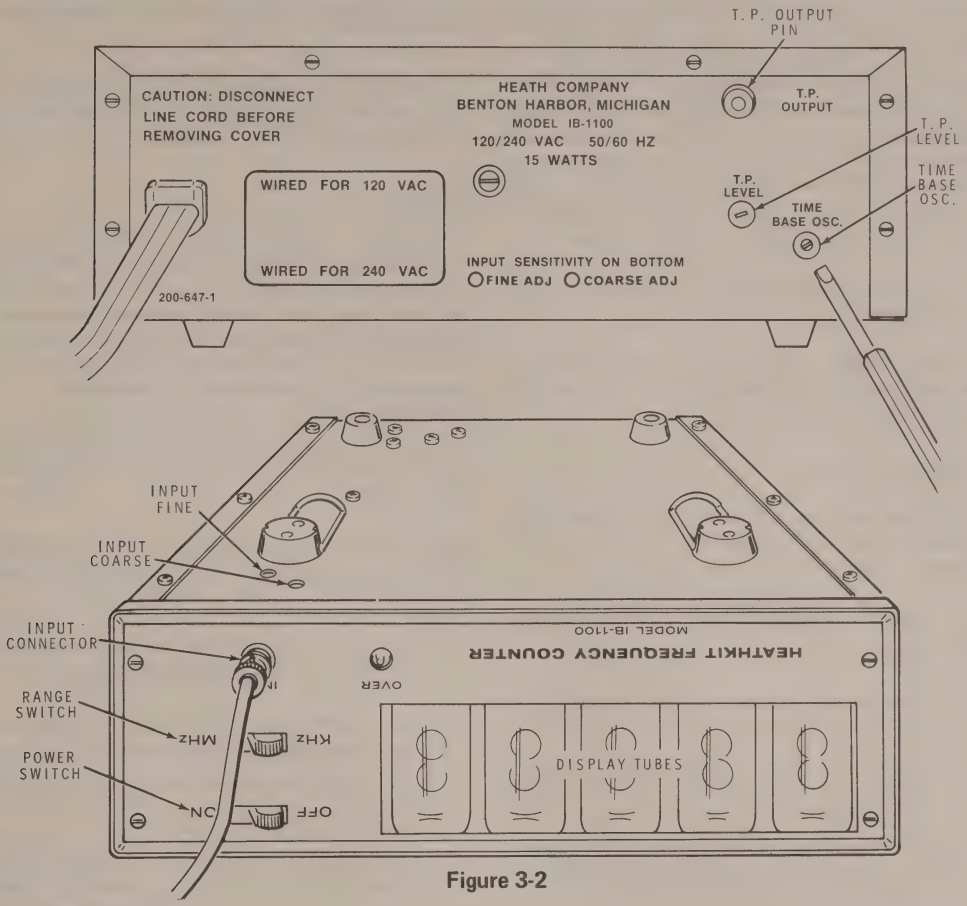


Figure 3-2

INPUT SENSITIVITY

Refer to Figure 3-2 for the following steps.

NOTE: In the following steps the terms clockwise and counterclockwise are used as you view the rear panel from the back of the instrument.

( ) 1. Be sure the TP LEVEL control is fully clockwise and the INPUT FINE control is at midrange.

( ) 2. Connect the test cable to the INPUT connector of the Counter.

( ) 3. Connect the inner lead of the test cable to the TP OUTPUT pin. (The shield lead requires no connection).

( ) 4. Push the RANGE switch to MHz.

( ) 5. If a reading of 01.000 is not displayed, use the screwdriver end of your white alignment tool to adjust the INPUT COARSE control until this reading appears.

( ) 6. Turn the TP LEVEL control counterclockwise very slowly until the 1 MHz reading just disappears or changes to a lower number.

( ) 7. Readjust the INPUT COARSE control very slowly until the 1 MHz reading is again obtained.

( ) 8. Repeat steps 6 and 7 until the TP LEVEL control is turned as far counterclockwise as possible and the counter still displays 1 MHz.

( ) 9. Repeat steps 6, 7, and 8 using the INPUT FINE control.

This completes the calibration of your Frequency Counter. Proceed to the "Operation" section on Page 35.

With Instruments

The accuracy of your Counter depends to a great extent upon the care and accuracy that you exercise in performing the following steps. These steps are designed to be used with precision equipment to calibrate the clock and the input sensitivity of your Counter. If at any time you do not obtain the results called for in a step, refer to the "In Case of Difficulty" section on Page 36 to correct the problem.

NOTE: In the following steps, the cabinet shell should remain on the Counter.

( ) Turn the Counter on and allow it to warm up for 30 minutes. This is MOST IMPORTANT for an accurate calibration.

INPUT SENSITIVITY

This adjustment requires the use of a signal generator with a continuously variable output from 25 mV to 0.5 volt rms, capable of generating at least a 1 MHz signal.

Refer to Figure 3-3 (fold-out from Page 30) for the following steps.

( ) 1. Connect the test cable to the INPUT connector of the Counter.

( ) 2. Connect the Counter test cable to the output of the signal generator.

( ) 3. Select a frequency between 1 MHz and 30 MHz. Set the signal generator output voltage to approximately 0.5 volt rms.

( ) 4. If the Counter does not indicate this frequency, use your white alignment tool and adjust the INPUT COARSE control (see Figure 3-2 on Page 33) until the correct frequency is displayed.

( ) 5. Reduce the signal generator output voltage until the display becomes unstable or goes to zero.

( ) 6. Slowly readjust the INPUT COARSE control to again obtain a correct display.

( ) 7. Repeat steps 5 and 6 until you reach the smallest signal generator output voltage that still produces a correct display on the Counter.

( ) 8. Repeat steps 5, 6, and 7 using the INPUT FINE control.

NOTE: The TP LEVEL control is used only to vary the signal level at the TP OUTPUT during the "Calibration Without Instruments."

CLOCK

This calibration can be performed with either a frequency counter and a signal generator (capable of a 1-30 MHz, 250 mV output) or with a known, stable, laboratory standard frequency. Determine which of these methods you will use. Then complete the steps under the appropriate heading.

Calibration With a Frequency Counter and Signal Generator

Refer to Figure 3-4 (fold-out from Page 30) for the following steps.

NOTE: The accuracy of your Counter, for this type of calibration, is dependent on the accuracy of the test frequency counter.

( ) Connect the test leads of the test frequency counter to the output terminals of the signal generator.

( ) Also connect the test leads of your Counter to the output terminals of the signal generator.

( ) Press the RANGE switch to the kHz position for maximum resolution.

( ) Set the signal generator to any convenient freqency between 1 MHz and 30 MHz at 250 mV to 500 mV output.

( ) Use the white alignment tool and adjust the TIME BASE OSC capacitor (see the inset drawing on Figure 3-4, fold-out from Page 30) until your Counter indicates exactly the same frequency as the test frequency counter.

( ) Disconnect the test leads.

This completes the calibration of your Frequency Counter. Proceed to the "Operation" section .

Calibration With a Known Laboratory Standard Frequency

NOTE: It is essential that the known frequency source (frequency of your choice between 1-30 MHz) be absolutely stable. The accuracy of this type of calibration is entirely dependent on the accuracy of this known frequency.

( ) Connect the known frequency to the test cable of the Counter.

( ) Push the RANGE switch to the kHz position for maximum resolution. NOTE: If the frequency is 100 kHz or higher, the overrange lamp will be lighted.

( ) Use the white alignment tool and adjust the TIME BASE OSC capacitor until the known frequency is exactly indicated on your Counter.

This completes the calibration of your Frequency Counter. Proceed to the "Operation" section .

OPERATION

Refer to Figure 3-5 (fold-out from Page 41) for a description of the display, control, and adjustment functions.

CAUTION: Use ONLY the center conductor of the input lead of your Counter to check the frequency of an ac line voltage. Connecting the ground input lead to the "hot" (ungrounded) side of an ac line may result in a blown fuse and/or damage to your Counter.

CONTROLS

This Frequency Counter has only two controls: the Power ON/OFF switch and the MHz/kHz Time Base switch. The Time Base switch selects a 1 millisecond time base in the MHz position, or a 1 second time base in the kHz position.

INPUT PROBES AND CABLES

Any standard 10 megohm oscilloscope probe can be used with this Counter. Refer to the Maximum Input Voltage for the maximum AC voltage that can be applied to the INPUT of the Counter at various frequencies. Note that even though the input of the Counter is AC coupled, the DC input level is limited to 200 volts.

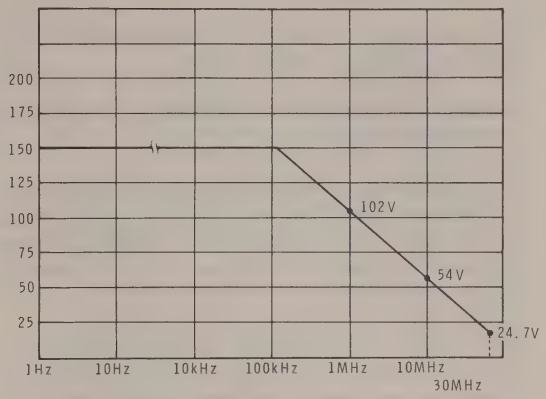
When you connect your Counter to a transmission line, make sure that the line is properly terminated (low standing wave ratio) to avoid possible damage to the equipment under test.

READING THE COUNTER

CAUTION: Avoid any excessive voltages that could damage your Counter. Refer to the Maximum Input Voltage for maximum safe input voltages at various frequencies.

Maximum Input Voltage

Up to a frequency of 10 kHz, the maximum permissible input voltage is 150 volts rms. At frequencies above 100 kHz, the maximum input voltage must be derated according to the following graph.



MAXIMUM INPUT VOLTAGE DERATING CURVE

Unknown Frequencies

To measure an unknown frequency, push the Power switch to ON and the Range switch to kHz. Allow the Counter to reset to zero. Then apply the unknown frequency to the counter input. If the OVER (overrange) lamp lights up, the frequency is higher than 99.999 kHz and the Range switch should be pushed to MHz. If the display then constantly changes in a random manner, the frequency is higher than the Counter's capability, or the input level is too low.

The Display

Frequencies lower than 100 kHz can be read directly to a resolution of ±1 Hz in the kHz position of the Range switch. Frequencies of 100 kHz and higher (within the range of the Counter) can be read to ±1 Hz by using both Range switch positions. A frequency of 12,345,678 Hz would be displayed as follows:

Range Switch	Display	Overrange Lamp
MHz	12.345	Off
kHz	45.678	On

IN CASE OF DIFFICULTY

This three-part section gives suggestions for locating and resolving difficulties.

The first part, "General Troubleshooting Information," deals with difficulties which exist upon completion of the assembly of your kit, and is primarily directed to soldering and assembly problems.

The second part consists of a "Troubleshooting Chart," which gives difficulties and likely causes.

The third part, "Important Wave Shapes," contains charts with significant waveforms.

If the above checks do not locate the problem, the difficulty may be a component. Read the "Circuit Description" (Pages 42 through 45) and refer to the Schematic Diagram (fold-out from Page 55) to help you determine where the trouble is.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover .

GENERAL TROUBLESHOOTING INFORMATION

1. Make sure you have power at the transformer primary.

2. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the kit builder.

3. Most problems result from poor connections and soldering. Use a magnifying glass and check all solder connections to be sure they are soldered as described in the "Soldering" section of the "Kit Builders Guide." Also check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring. Look for solder bridges between circuit board foils. Compare your foil pattern with the "X-Ray Views" on Pages 46 and 47. Many troubles can be eliminated by reheating all connections to make sure they are soldered as described in the "Soldering" section of the "Kit Builders Guide."

4. Make sure that the proper transistor has been installed at each location and that each lead is in the proper hole.

5. Press each integrated circuit into its socket so that each pin will make a secure connection. Be sure that each IC pin is properly installed in its socket and not bent out or under the IC.

6. Check each IC to make sure its index mark matches the half-circle on the circuit board.

7. Check the values of the parts. Make sure the proper part has been wired into the circuit at each location. For example, a 680 Ω (blue-gray-brown) resistor could easily be installed in place of a 68 Ω (blue-gray-black) resistor.

8. Check the continuity of the circuit board foils, including those places where a foil runs through a hole to connect a top foil and a bottom foil together. (Such a hole may also be used for mounting a component.) If you find an open foil, bridge it through the circuit board with a jumper wire. CAUTION: Never run a drill through any circuit board hole, as this will destroy any foil connection that goes through the hole.

9. A review of the "Circuit Description" may help you to determine where the trouble is.

10. The functional areas of the circuit board are shown on Page 54.

Substitution

Corresponding components of the circuitry for each display tube can be interchanged with the components of another tube. IC's 1 through 5 can be interchanged, for example.

If one display tube shows two digits simultaneously, interchange it with one of the other tubes to determine if the tube or the circuit is faulty. If the circuit is faulty and there are no solder bridges on the associated foil, interchange the decoder/driver IC with one of the others. This method can be used with other single digit problems and can be extended to interchanging the memory latches and the decade counter integrated circuits.

Clock Circuit

Verify that the clock oscillator and divider circuits are operating properly by checking the voltage at pin 12 of IC24. The meter should alternately indicate 0 volts for one second and then four to five volts for one second.

Counting and Display Circuits

As shown in Figure 3-6, a counting and display circuit consists of the decade counter and the associated storage register, decoder/driver, and display tube. A high input impedance voltmeter can be used to check the logic states of only the memory latches, decoder/drivers, and display tubes. For these voltage checks, a "high" is 2.4 VDC or more, whereas a "low" is .8 VDC or less.

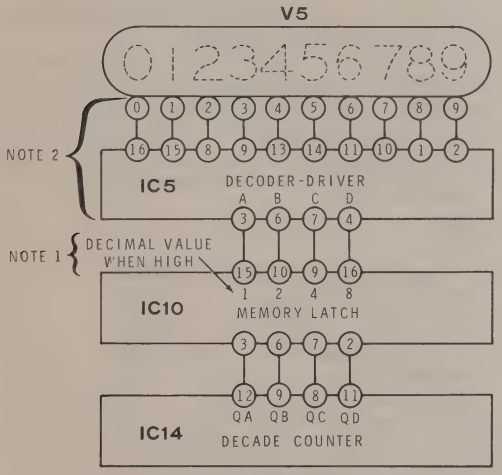


Figure 3-6

The decade counters cannot be accurately checked with a voltmeter, as their outputs change rapidly with the count. The substitution method described above is one way to check them.

NOTES:

1. Add the values of the highs to determine the decimal equivalent. For example, if pins 15 and 9 of IC10 are high (pins 10 and 16 remain low), then the decimal equivalent is 5 (1+4=5). If only pin 16 is high, the decimal equivalent is 8. If all pins are low, the decimal equivalent is 0.

2. All outputs of the decoder/driver will be high except one. The one output which is low will turn on the corresponding number in the display tube. For example, if pin 14 is low, number 5 will be turned on.

EXAMPLE

1. If tube V5 displays a "5" when you know a "3" should be seen, transpose IC14 (in this example) with one of the other decade counters whose display is correct. If V5 still displays a "5," it is reasonable to assume the IC is good. If the display changes to a "3," the IC is probably faulty, although the original IC should be inserted in its socket again to make sure.

2. If the display remains a "5," check the outputs of the memory latch IC10. If pins 15 and 9 are high and pins 16 and 10 are low, then the memory latch is probably good (1+4=5).

3. The decoder/driver, IC5, should have pin 14 low to turn on the 5 in the display tube, and all other output pins should be high. If pin 9 should be low, which turns on the 3 in the display tube, but a 5 is displayed, then the fault is probably in the tube and it should be substituted with one of the others for confirmation.

4. If the foregoing checks are all indicative of a "5," then it is reasonable to assume that the difficulty lies ahead of the counting and display circuits.

CIRCUIT BOARD MAINTENANCE

To obtain access to the foil side of the circuit board for maintenance, follow the numbered steps:

1. Remove the cabinet shell.

2. Unsolder and remove the black wire from the TP output solder lug on the inside of the rear panel.

3. Remove the mounting hardware which secures Q12 to the inside of the rear panel.

4. Carefully slide the circuit board from under the back of the output connector and turn the board up on edge, as when you connected the transformer leads.

5. When you reinstall the circuit board, remember to again push the white wire from the input connector down against the board.

Troubleshooting Chart

CONDITION	POSSIBLE CAUSE
One readout does not reset to zero with the input shorted.	1. Check associated decade counter, memory latch, and decoder/driver IC's.
Readouts will not reset to zero in the kHz or MHz range.	1. Q8. 2. IC23. 3. IC21. 4. IC15, IC16, IC17.
Counter functions normal in MHz range but not in kHz range.	1. IC24. 2. Switch SW2. 3. IC20.
Display tubes will not light.	1. +100-volt supply (D7 and transformer). 2. Check for a solder bridge on the 100-volt line.
One or more display tubes will not light.	1. Check associated tube pins, memory latch (IC6 through IC10) and decoder/driver IC's (IC1 through IC5).
One display tube does not indicate correct numeral from known frequency source.	1. Check associated decade counter, memory latch, and decoder/driver IC's.
Counter resets to zero but will not count.	1. Range switch not firmly pressed to correct position. 2. Insufficient amplitude of input signal. 3. Transistors Q1 through Q7. 4. IC25.
OVER (overrange) lamp does not function or is on continuously.	1. Transistor Q10. 2. IC22. 3. IC24.
Counting sequence is displayed during gating.	1. Memory transfer line, Q9. 2. IC21, IC23.
Decimal point does not light.	1. Resistor R22. 2. Interchange tube V3 with another display tube.
One or more display tube numbers on at all times.	1. Check for solder bridge on associated tube foil and decoder/driver. 2. Open foil between two IC pins in the counting and display circuit. 3. Poorly soldered connection in the counting and display circuit.

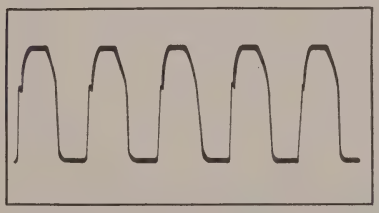
CONDITION	POSSIBLE CAUSE
Numbers displayed with input open, but zeros displayed with input shorted.	1. Push the white wire between hole J and the input connector down against the circuit board.
Random count with input cable disconnected.	1. Scrape paint under BNC connector on back of panel.
Sensitivity reduced after warmup.	1. Failure to allow 30-minute warmup prior to initial adjustment.
All display tubes show all 10 numbers at once.	1. 5 volt supply. 2. Q12, Q13, D5, D6, Q11.
+5 volt supply too high.	1. Q12, Q13.

IMPORTANT WAVE SHAPES

This section presents wave shapes that should be present at various points in your Frequency Counter. The wave shapes are line drawings of photographs of the graticule of a Textronix Model 547 Oscilloscope. A low capacity X10 probe was used and the oscilloscope was set for .1 volt-per-division. The time base is indicated for each drawing. Use the MHz position of the Range switch. All wave shapes are approximately 3.5 to 4.5 volts. The bottom horizontal lines of the wave shapes represent approximately 0 to .4 volts.

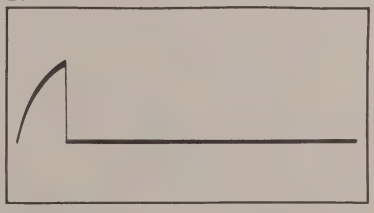
IC 15

Pin 14
.5 μs/Div.
1 MHz clock.



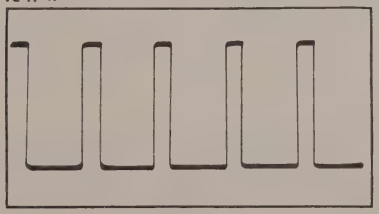
Q9

Collector
.2 ms/Div.
memory
transfer pulse.



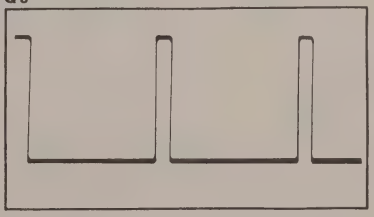
IC 17 *

Pin 11
.5 ms/Div.
divided clock
pulse.



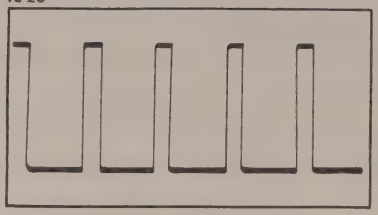
Q8

Collector
.5 ms/Div.
positive
reset pulse.



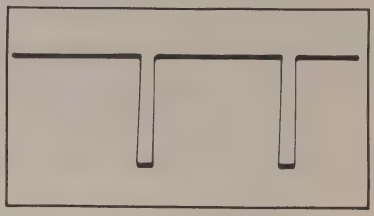
IC 20

Pin 11
.5 sec/Div.
divided clock
pulse.



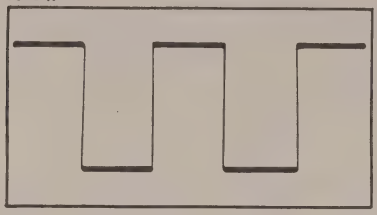
IC 23

Pin 11
.5 ms/Div.
negative
reset pulse.



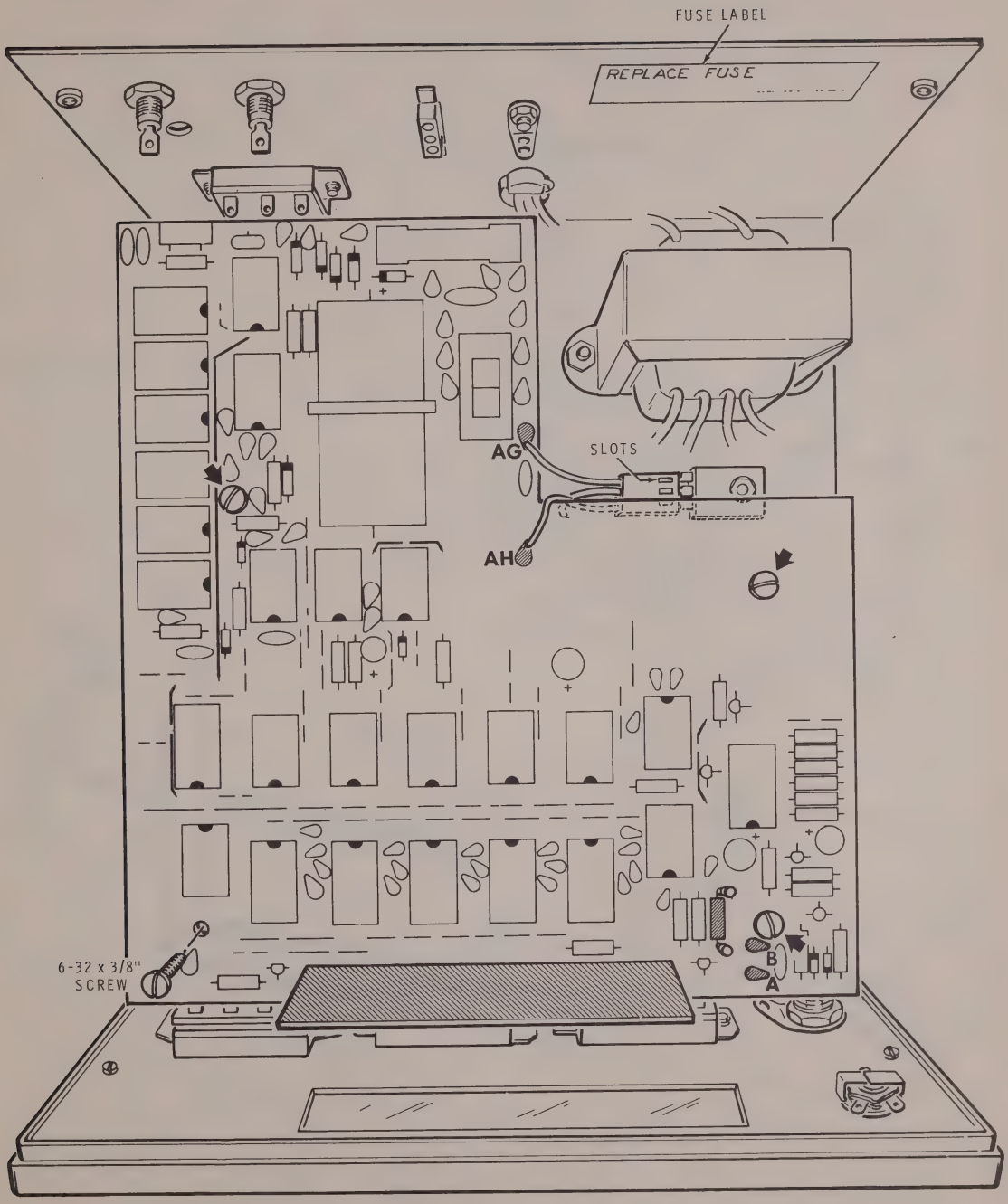
IC25*

Pin 3
.5 ms/Div.
1 ms clock
pulse.



*The waveform may be notched at the top. This is normal.

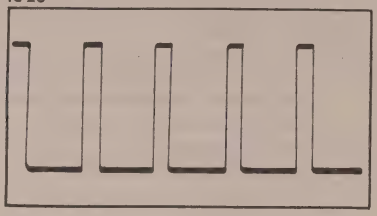
ON BOOKLET



PICTORIAL 4-7

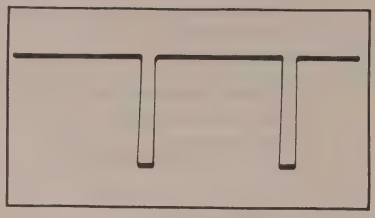
IC 20

Pin 11
.5 sec/Div.
divided clock
pulse.



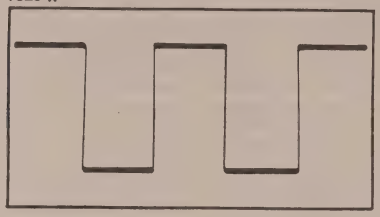
IC 23

Pin 11
.5 ms/Div.
negative
reset pulse.



IC25*

Pin 3
.5 ms/Div.
1 ms clock
pulse.



*The waveform may be notched at the top. This is normal.

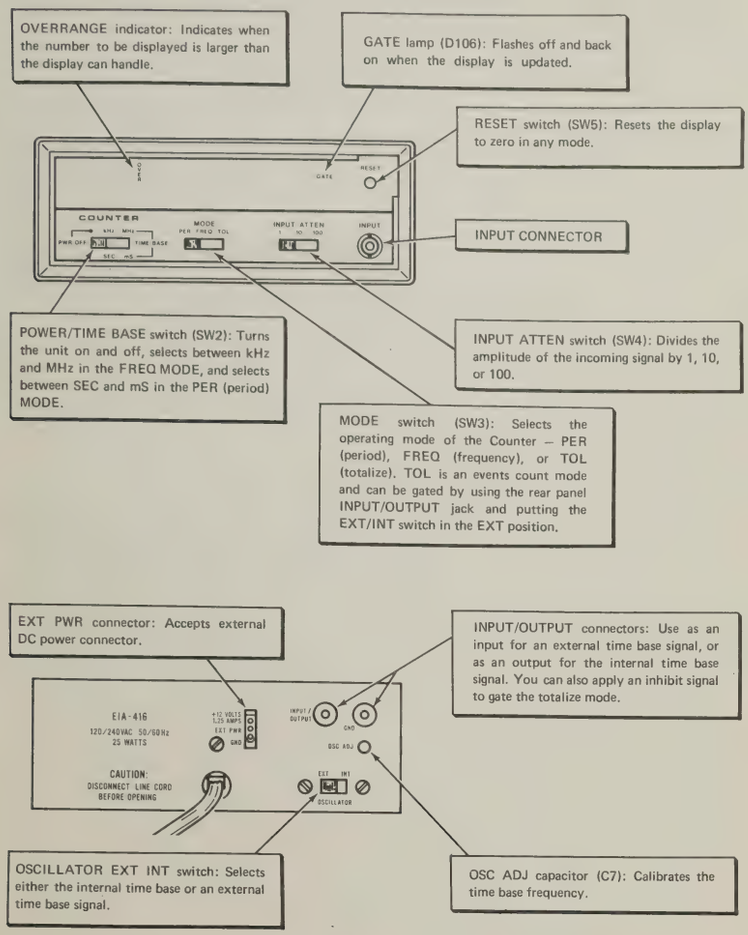
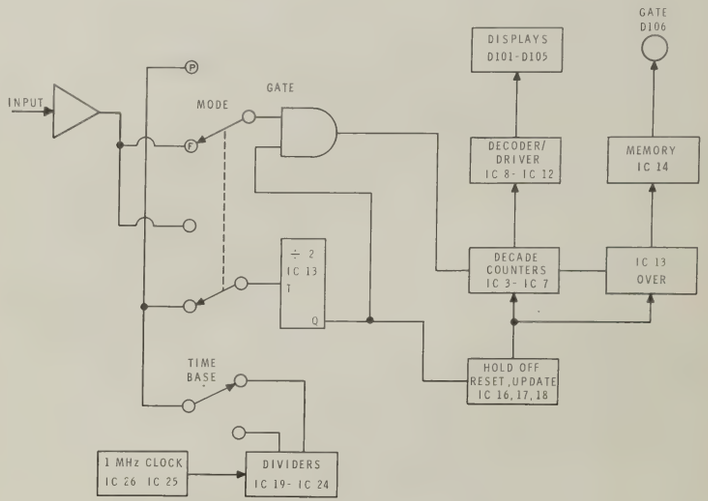
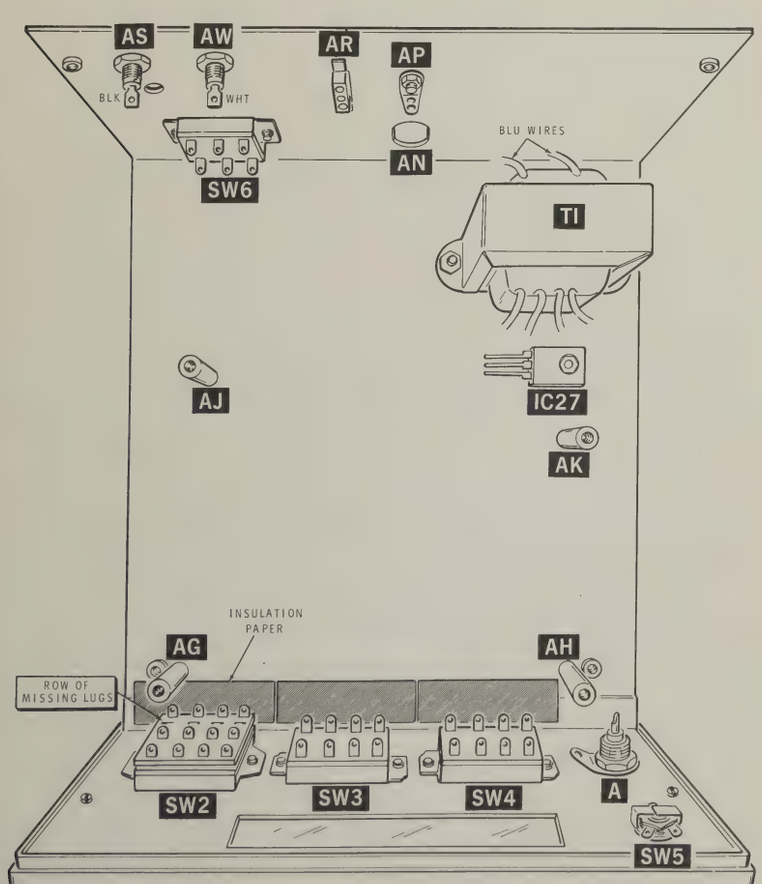

OVERRANGE indicator: Indicates when the number to be displayed is larger than the display can handle.
GATE lamp (D106): Flashes off and back on when the display is updated.
RESET switch (SW5): Resets the display to zero in any mode.
INPUT CONNECTOR
POWER/TIME BASE switch (SW2): Turns the unit on and off, selects between kHz and MHz in the FREQ MODE, and selects between SEC and mS in the PER (period) MODE.
INPUT ATTEN switch (SW4): Divides the amplitude of the incoming signal by 1, 10, or 100.
MODE switch (SW3): Selects the operating mode of the Counter – PER (period), FREQ (frequency), or TOL (totalize). TOL is an events count mode and can be gated by using the rear panel INPUT/OUTPUT jack and putting the EXT/INT switch in the EXT position.
EXT PWR connector: Accepts external DC power connector.
INPUT/OUTPUT connectors: Use as an input for an external time base signal, or as an output for the internal time base signal. You can also apply an inhibit signal to gate the totalize mode.
OSCILLATOR EXT INT switch: Selects either the internal time base or an external time base signal.
OSC ADJ capacitor (C7): Calibrates the time base frequency.
COUNTER
EIA-416
120/240VAC 50/60Hz
25 WATTS
CAUTION:
DISCONNECT LINE CORD
BEFORE OPENING

Figure 6

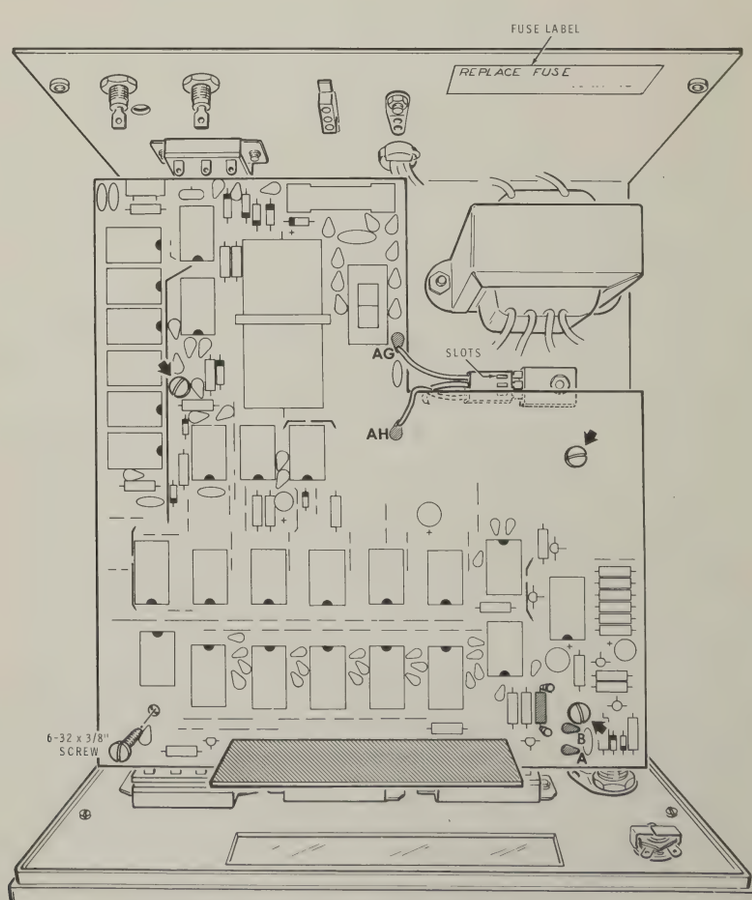


BLOCK DIAGRAM

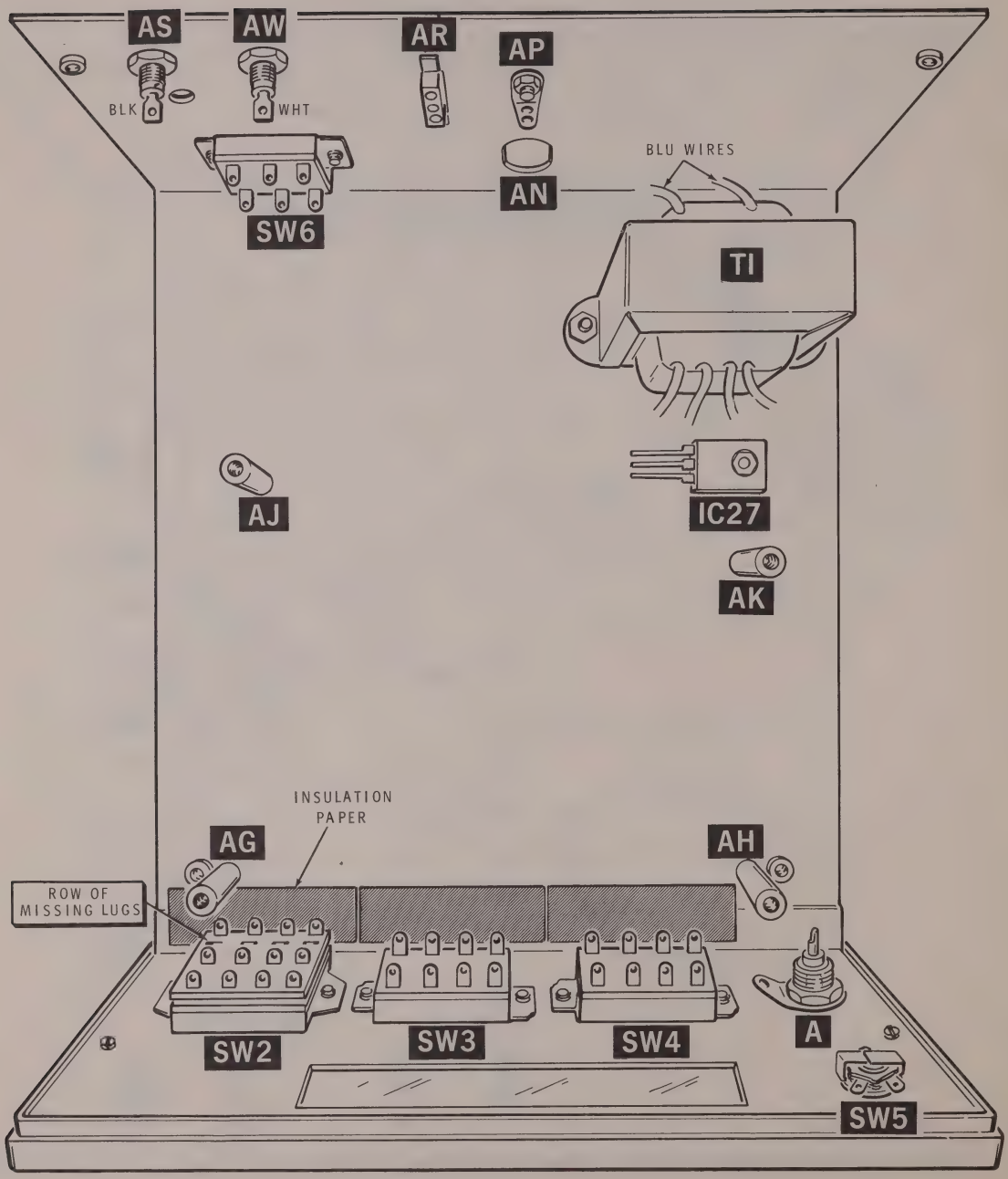
ILLUSTRATION BOOKLET



PICTORIAL 4-1



PICTORIAL 4-7



PICTORIAL 4-1

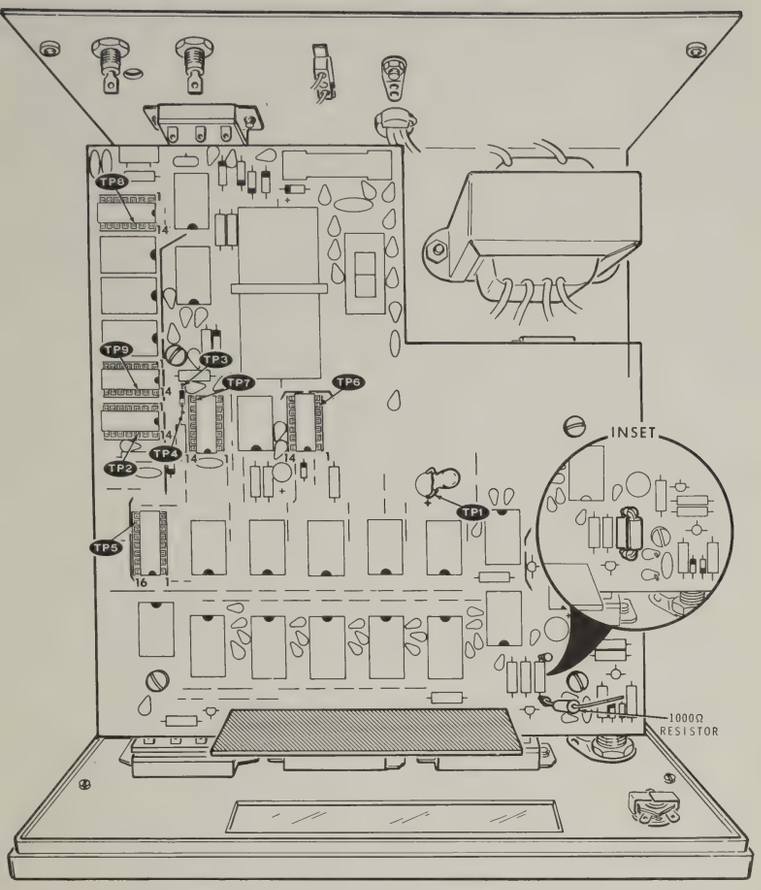
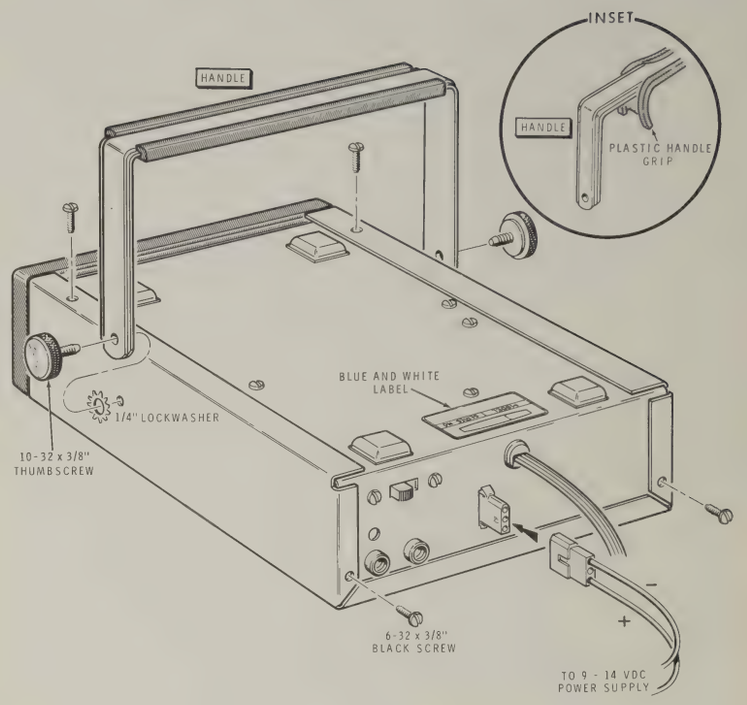


Figure 2



PICTORIAL 4-8

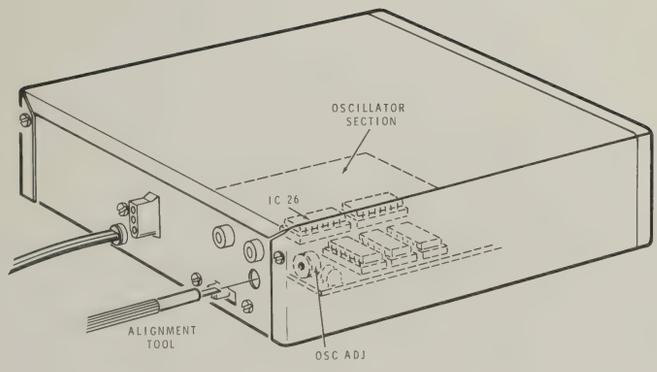


Figure 4

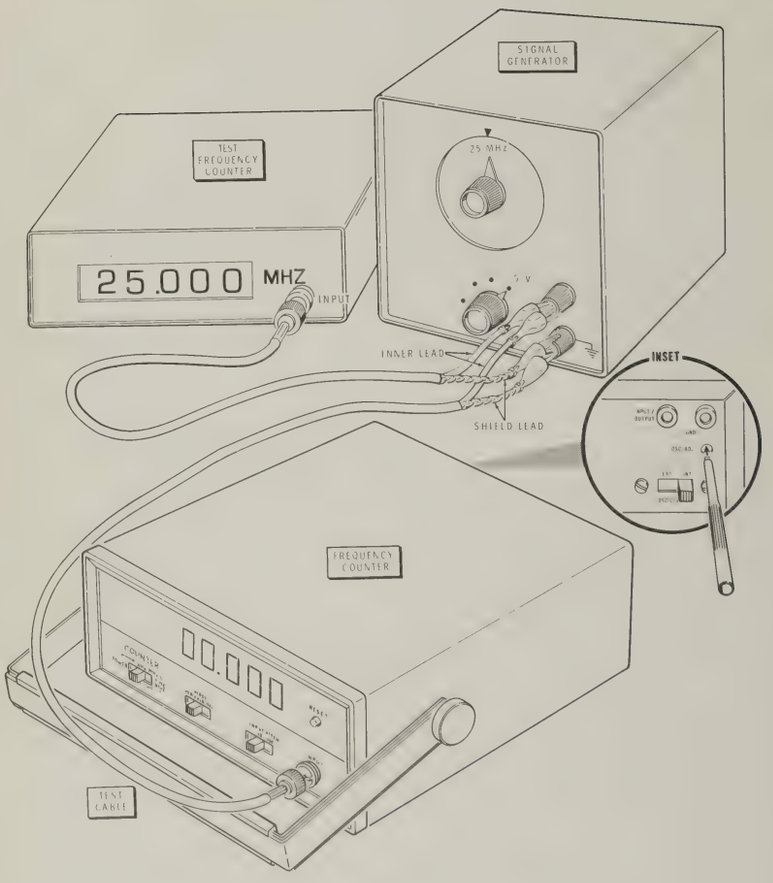
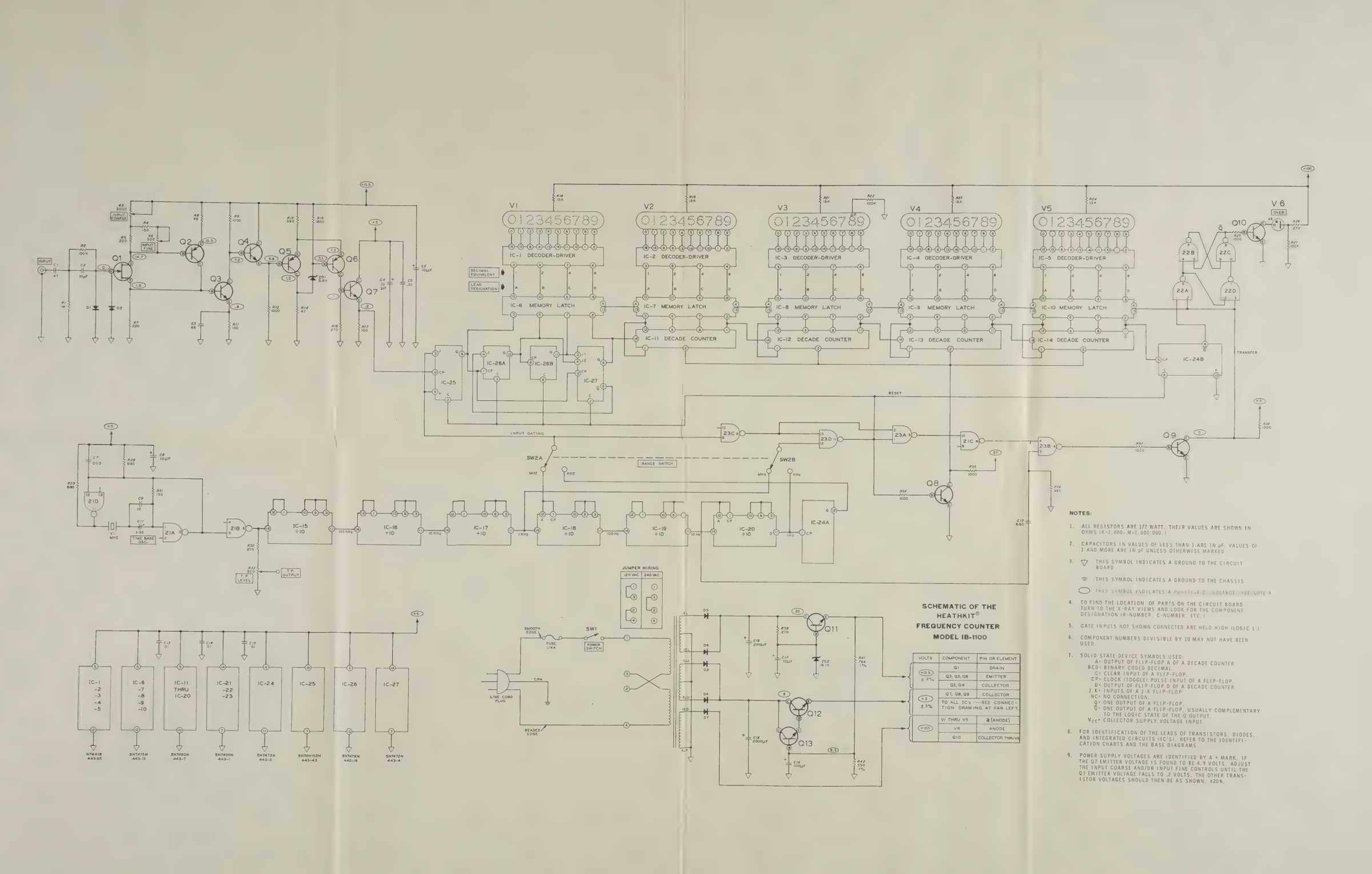


Figure 5



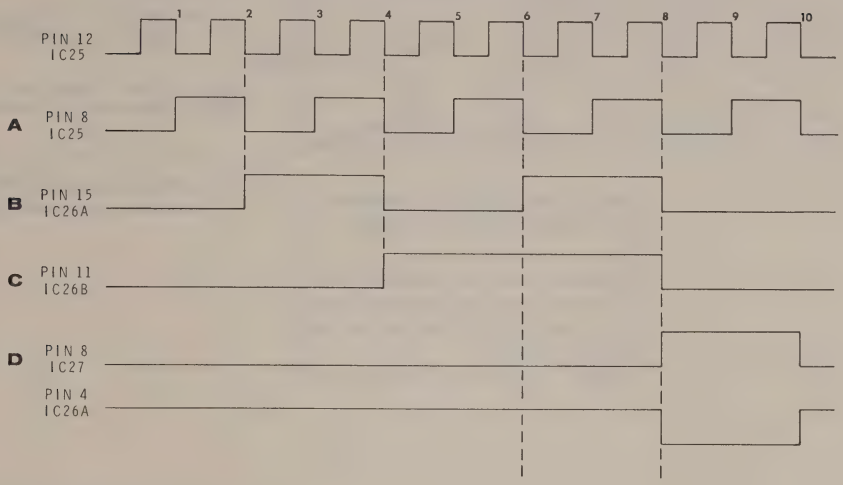
SCHEMATIC OF THE HEATHKIT® FREQUENCY COUNTER MODEL IB-1100

VOLTS	COMPONENT	PIN OR ELEMENT
+15 S ± 2%	Q1	DRAIN
	Q2, Q5, Q6	EMITTER
	Q3, Q4	COLLECTOR
+5 ± 5%	Q7, Q8, Q9	COLLECTOR
	TO ALL IC's ----SEE CONNECTION DRAWING AT FAR LEFT.	
+100	V1 THRU V5	a (ANODE)
	V6	ANODE
	Q10	COLLECTOR THRU R

NOTES:

1. ALL RESISTORS ARE 1/2 WATT. THEIR VALUES ARE SHOWN IN OHMS (K=1,000; M=1,000,000.)
2. CAPACITORS IN VALUES OF LESS THAN 1 ARE IN µF; VALUES OF 1 AND MORE ARE IN pF UNLESS OTHERWISE MARKED
3. ▽ THIS SYMBOL INDICATES A GROUND TO THE CIRCUIT BOARD
   ⏚ THIS SYMBOL INDICATES A GROUND TO THE CHASSIS
   ⬭ THIS SYMBOL INDICATES A POSITIVE D.C. VOLTAGE. SEE NOTE 9
4. TO FIND THE LOCATION OF PARTS ON THE CIRCUIT BOARD TURN TO THE X-RAY VIEWS AND LOOK FOR THE COMPONENT DESIGNATION (R-NUMBER, C-NUMBER, ETC.)
5. GATE INPUTS NOT SHOWN CONNECTED ARE HELD HIGH (LOGIC 1.)
6. COMPONENT NUMBERS DIVISIBLE BY 10 MAY NOT HAVE BEEN USED.
7. SOLID STATE DEVICE SYMBOLS USED:
   A- OUTPUT OF FLIP-FLOP A OF A DECADE COUNTER
   BCD- BINARY CODED DECIMAL
   C- CLEAR INPUT OF A FLIP-FLOP.
   CP- CLOCK (TOGGLE) PULSE INPUT OF A FLIP-FLOP.
   D- OUTPUT OF FLIP-FLOP D OF A DECADE COUNTER.
   J, K- INPUTS OF A J-K FLIP-FLOP
   NC- NO CONNECTION.
   Q- ONE OUTPUT OF A FLIP-FLOP.
   $\bar{Q}$- ONE OUTPUT OF A FLIP-FLOP, USUALLY COMPLEMENTARY TO THE LOGIC STATE OF THE Q OUTPUT.
   V_{CC}- COLLECTOR SUPPLY VOLTAGE INPUT.
8. FOR IDENTIFICATION OF THE LEADS OF TRANSISTORS, DIODES, AND INTEGRATED CIRCUITS (IC'S), REFER TO THE IDENTIFICATION CHARTS AND THE BASE DIAGRAMS.
9. POWER SUPPLY VOLTAGES ARE IDENTIFIED BY A + MARK. IF THE Q7 EMITTER VOLTAGE IS FOUND TO BE 4.9 VOLTS, ADJUST THE INPUT COARSE AND/OR INPUT FINE CONTROLS UNTIL THE Q7 EMITTER VOLTAGE FALLS TO 5 VOLTS. THE OTHER TRANSISTOR VOLTAGES SHOULD THEN BE AS SHOWN, ±20%.

PULSE RELATIONSHIPS OF THE FIRST DECADE COUNTER



	LOGIC LEVEL			
COUNT	A	B	C	D
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

Figure 4-2

SPECIFICATIONS

Frequency Range	1 Hz to over 30 MHz.
Accuracy	±1 digit ± time base stability.
Sensitivity (after 30-minute warmup)	100 mV rms typical, 250 mV rms maximum.
Gate Time	1 millisecond or 1 second; with automatic reset.
Input Impedance	1 MΩ, shunted by less than 20 pF.
Maximum Input Voltage	150 V rms to 100 kHz. Derate 48 volts per decade above 100 kHz. (Maximum DC input is 200 volts.)
Time Base Frequency	1 MHz.
Time Base Stability (After 30-minute warmup)	<±3 PPM between 22°C and 37°C. <1 PPM/Month after 30 days operation. <±20 PPM between 10°C and 40°C.
Front Panel Indications	Five 10-numeral, cold-cathode tubes, plus a neon lamp for Overrange indication.
Rear Panel	Time Base Osc adjustment, TP Level control, TP Output terminal.
Front Panel	Power OFF-ON switch, Range MHz/kHz switch, and BNC Input connector.
Ambient Temperature Range	Storage – 55°C to 80°C. Operating 10°C to 40°C.
Power Requirements	110-130 or 220-260 Vac, 50/60 Hz, 15 watts.
Dimensions	7-1/4" wide x 3-1/8" high x 9-1/4" deep.
Net Weight	4 pounds.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

FRONT PANEL VIEW

DISPLAY TUBES

The Range Switch determines whether kHz or MHz are displayed to the left of the decimal point.

POWER SWITCH

Turns the counter ON and OFF.

RANGE SWITCH

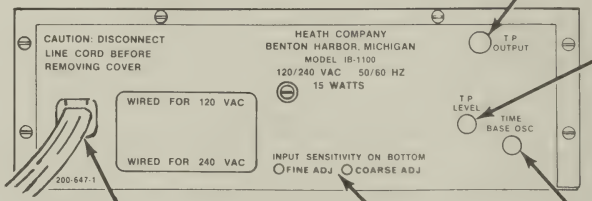
Select the kHz or MHz range.

INPUT CONNECTOR

OVERRANGE LAMP

Indicates when the frequency being counted is too high to be displayed with the RANGE switch in its present position.

REAR PANEL VIEW



TP OUTPUT

Provides an external connection for test and alignment procedures.

TP LEVEL

Provides an external access point for adjustment of the TP LEVEL (test point level) control.

TIME BASE OSC

Provides an external access point for adjustment of the TIME BASE OSCILLATOR capacitor.

LINE CORD AND STRAIN RELIEF

INPUT SENSITIVITY (Right, front corner of bottom)

Provides an external access point for adjustment of the input sensitivity.

Figure 3-5

CIRCUIT DESCRIPTION

Refer to the Block Diagram (fold-out from Page 45) and to the Schematic Diagram (fold-out from Page 55) while you read this "Circuit Description."

GENERAL

Your Heathkit Frequency Counter includes a 1 MHz clock and scaler that produces an exact time base of 1 second or 1 millisecond. This time base controls all of the gating circuits and determines the overall accuracy of the Counter.

The output of this clock and scaler circuit is applied to the reset, gate, and memory circuits to reset the counters, gate the first decade counter for a precise period, and to transfer the count to the decoder and display tubes.

The input amplifier and Schmitt trigger circuits accept and shape the input signal into a squarewave, and then apply this signal to the first decade counter. When this counter is turned on, the pulses from the input and shaper circuits are counted in BCD (Binary-Coded-Decimal) logic, with each tenth pulse passing to the next decade counter. The outputs of the decade counters are in the 1-2-4-8 or "natural" binary code.

When the transfer pulse is applied to the memory latches, they accept the accumulated BCD count from the decade counters and hold this count at their outputs until the next transfer pulse. The outputs are connected to the decoder/drivers, which translate the BCD count into a decimal count and turn on the proper numbers in the display tubes. Any tenth pulse from the fifth decade counter triggers the overrange detector and readout circuit to cause the overrange (Over) lamp to light. The reset pulse occurs after the transfer pulse and resets the counters to zero for the next counting cycle.

INPUT CIRCUIT

The input circuit consists of a network of capacitors, resistors, transistors, and diodes that function as follows: C1 removes any dc component from the applied input signal. C2 prevents attenuation of high frequency signals, and R2, D1, and D2 prevent overloading of the input transistors.

Input transistors Q1 and Q2 are direct coupled with 100% negative feedback. These transistors provide wide bandwidth, high input impedance, low output impedance, and a gain of near unity.

Transistor Q3 is an amplifier with emitter compensation, and is isolated from the Schmitt trigger circuit by the emitter-follower configuration of transistor Q4.

SCHMITT TRIGGER

The Schmitt trigger circuit is a regenerative bistable circuit which produces a square-wave output each time it is triggered and reset. Schmitt trigger transistors Q5 and Q6 are emitter-coupled for current-mode operation so they will produce the fast switching time required for operation of the first decade counter. Operating current for the trigger is set by resistor R13, while R15 sets the bias of zener diode ZD1 in its zener region.

Input Sensitivity controls R3 and R6, by virtue of dc coupling, adjust the threshold of the Schmitt trigger circuit to insure that very small input signals can be measured with the counter.

Emitter follower transistor Q7 keeps the TTL (transistor-transistor-logic) in the counter circuit from loading the Schmitt trigger circuit.

1 MHz CLOCK AND SCALER

A 1 MHz crystal and gates A and D of IC21 are used to form a TTL – compatible clock. Capacitors C9 and C11 provide the proper capacitive load for the crystal. C11 is variable to allow for precise calibration of the oscillator. Resistors R28. R29, and R31 assure efficient starting of the clock oscillator. Gate B of IC21 provides buffering action between the oscillator and the first decade divider of the time base scaler.

The scaler consists of six decade dividers. The Range switch selects the output from the third or sixth divider for the reset pulse, and either the A output of IC18 or the Q output of IC24A for the input gating pulse. Therefore, the Range switch can provide either a 1-millisecond (MHz) or a 1-second (kHz) time base for the gating, reset, and memory circuits. The A output of IC20 provides the transfer pulse.

GATING, MEMORY, AND RESET

The gating, memory, and reset circuit controls the times that an input signal is gated into the counting circuits, the times that the accumulated information is passed from the counting circuits to the readout circuits, and the times that the counter circuits are reset to zero to begin a new counting cycle.

Figure 4-1 (fold-out from Page 42) shows the pulse relationships of the gating, memory, and reset circuit. Refer to this Figure as you read the following information.

When the Range switch is in the MHz position, the "gate open" signal is a 1-millisecond pulse that is obtained from the A output (pin 12) of IC18. The input signal enters the counters during the millisecond that the logic 1 of the gating signal is present on the J and K inputs of the first flip-flop of the first decade divider (pins 9 and 3 of IC25).

The reset pulse is derived by combining the inverted gate signal with the output of IC17 in IC23D. During the time that both the output of IC17 and the inverted gate signal from IC23C are high, a logic 1 at both inputs of NAND gate IC23D causes a logic 0 reset pulse to be applied to the first DCU (decade counting unit) and to IC24B, the overrange flip-flop. This reset pulse is inverted by Q8 to supply a logic 1 reset pulse to IC's 11 through 14. These reset pulses occur every two milliseconds, immediately prior to the gate opening.

The transfer signal is derived by combining the reset pulse (pin 11 of IC23D) with the inverted gate pulse in NAND gate IC23A. The resultant pulse is then inverted by IC21C.

A transfer pulse cannot occur during a reset pulse because IC23B is inhibited by a logic 0 on its pin 4 from IC21C. The transfer pulse can occur only when pin 4 is at a logic 1 and during a postive-going transition at the A output of IC20, which is differentiated by C12 and R36 and applied to IC23B as a positive spike. IC23B then has a logic 1 at each input and therefore a logic 0 output. The negative output spike is inverted by Q9 and the positive spike is applied as a transfer pulse to IC's 6 through 10, and IC's 22A and 22D.

Although the reset cycle occurs every two milliseconds, the differentiated A output of IC20 allows the transfer pulse to occur only every 200 milliseconds. Therefore, 100 count-reset cycles will occur for every memory update to prevent the appearance (due to the persistence of the human eye) of more than one lighted number in the last digit.

When the Range switch is in the kHz position, the "gate open" signal is a 1-second pulse that is obtained from the Q output (pin 12) of IC24A.

The reset pulse is derived in the same manner as with the Range switch in the MHz position, except that the basic signals are obtained from the D output (pin 11) of IC20 and the Q output of IC24A.

The transfer pulse is also derived in the same manner as with the Range switch in the MHz position, except that the gate reset cycle now occurs every two seconds and the transfer occurs every 200 milliseconds (unless inhibited by the presence of either a reset pulse or a gate-open pulse). Therefore, there are four transfer pulses for every gate reset cycle. These extra pulses, however, will have no effect on the readout since neither the "gate-open" nor reset can occur during their time duration. As a consequence, the same count is simply transferred four times.

FIRST DECADE COUNTER

Figure 4-2 (fold-out from Page 42) shows the pulse relationships in the first decade counter (IC25, IC26A, IC26B, IC27). Refer to this Figure as you read the following information.

This circuit is connected as an asynchronous BCD counter, and the flip-flops are triggered by negative-going pulses. Flip-flop IC25 is toggled by the signal from the Schmitt trigger circuit. As IC25 is toggled on every input pulse when both the J and K inputs are at logic 1, the Q output (A) goes to a logic 1 on the 1st, 3rd, 5th, 7th, and 9th counts.

These pulses are then applied to the toggle input of IC26A. However, because of the feedback loop from $\overline{Q}$ of IC27 to the J input of IC26A, IC26A is inhibited on the tenth count. This results in the Q output of IC26A being a logic 1 for the 2nd, 3rd, 6th, and 7th counts. IC26B is toggled by the Q output of IC26A on the 4th and 8th counts. Therefore, the Q output of IC26B is a logic 1 for the 4th, 5th, 6th, and 7th counts.

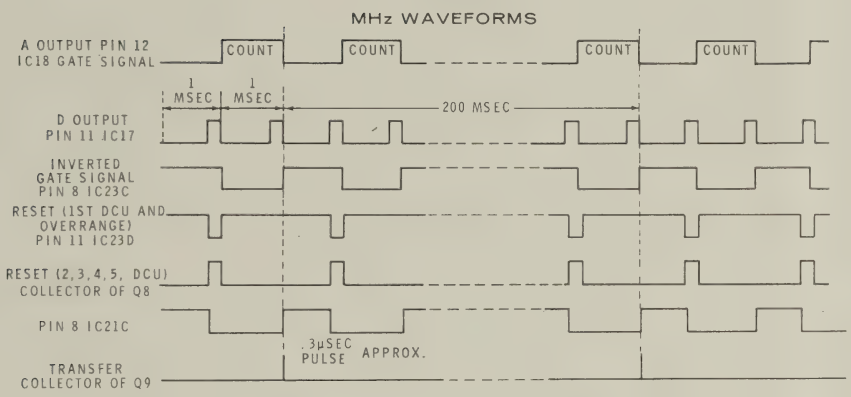
Two feed-forward loops are incorporated around IC27, which is toggled by the Q output of IC25, to inhibit its toggling on any pulse except the 8th and the 10th count. This is accomplished by connecting the Q outputs of IC26A and IC26B to the J inputs of IC27. As a result, IC27 will toggle only when both of the Q outputs from IC26A and IC26B are at logic 1. This results in the Q output of IC27 being at logic 1 for the 8th and 9th counts only. On the 10th count, IC25 toggles to a logic 0 at its Q output as its J input is a logic 0. IC26A and IC26B will stay at logic 0 as they were not toggled. IC27 is forced to logic 0 because its J input is at logic 0.

Reset is accomplished by taking all clear inputs of the flip-flops to a logic 0. These logic levels are supplied by IC23D. Counting is started when the J and K inputs of IC25 are taken to logic 1, and inhibited when these same inputs are returned to a logic 0. These logic levels are supplied by the A output of IC18 or the Q output of IC24A, as determined by the position of the Range switch.

PULSE RELATIONSHIPS OF THE GATING, MEMORY, AND RESET CIRCUIT

TRUTH TABLE
(EACH GATE)

INPUTS		OUTPUTS
A	B	
0	0	1
0	1	1
1	0	1
1	1	0


MHz WAVEFORMS
A OUTPUT PIN 12 IC18 GATE SIGNAL
COUNT
1 MSEC
1 MSEC
200 MSEC
D OUTPUT PIN 11 IC17
INVERTED GATE SIGNAL PIN 8 IC23C
RESET (1ST DCU AND OVERRANGE) PIN 11 IC23D
RESET (2, 3, 4, 5, DCU) COLLECTOR OF Q8
PIN 8 IC21C
.3μSEC PULSE APPROX.
TRANSFER COLLECTOR OF Q9

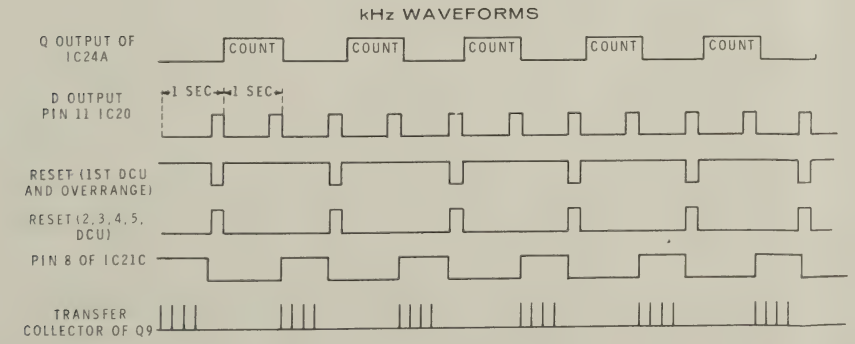
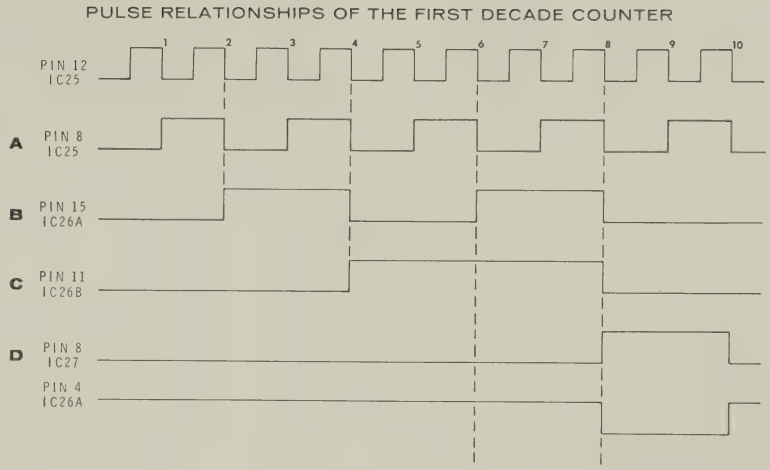


Figure 4-1



LOGIC LEVEL

COUNT	A	B	C	D
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

Figure 4-2

CIRCUIT DESCRIPTION

Refer to the Block Diagram (fold-out from Page 45) and to the Schematic Diagram (fold-out from Page 55) while you read this "Circuit Description."

GENERAL

Your Heathkit Frequency Counter includes a 1 MHz clock and scaler that produces an exact time base of 1 second or 1 millisecond. This time base controls all of the gating circuits and determines the overall accuracy of the Counter.

The output of this clock and scaler circuit is applied to the reset, gate, and memory circuits to reset the counters, gate the first decade counter for a precise period, and to transfer the count to the decoder and display tubes.

The input amplifier and Schmitt trigger circuits accept and shape the input signal into a squarewave, and then apply this signal to the first decade counter. When this counter is turned on, the pulses from the input and shaper circuits are counted in BCD (Binary-Coded-Decimal) logic, with each tenth pulse passing to the next decade counter. The outputs of the decade counters are in the 1-2-4-8 or "natural" binary code.

When the transfer pulse is applied to the memory latches, they accept the accumulated BCD count from the decade counters and hold this count at their outputs until the next transfer pulse. The outputs are connected to the decoder/drivers, which translate the BCD count into a decimal count and turn on the proper numbers in the display tubes. Any tenth pulse from the fifth decade counter triggers the overrange detector and readout circuit to cause the overrange (Over) lamp to light. The reset pulse occurs after the transfer pulse and resets the counters to zero for the next counting cycle.

INPUT CIRCUIT

The input circuit consists of a network of capacitors, resistors, transistors, and diodes that function as follows: C1 removes any dc component from the applied input signal. C2 prevents attenuation of high frequency signals, and R2, D1, and D2 prevent overloading of the input transistors.

Input transistors Q1 and Q2 are direct coupled with 100% negative feedback. These transistors provide wide bandwidth, high input impedance, low output impedance, and a gain of near unity.

Transistor Q3 is an amplifier with emitter compensation, and is isolated from the Schmitt trigger circuit by the emitter-follower configuration of transistor Q4.

SCHMITT TRIGGER

The Schmitt trigger circuit is a regenerative bistable circuit which produces a square-wave output each time it is triggered and reset. Schmitt trigger transistors Q5 and Q6 are emitter-coupled for current-mode operation so they will produce the fast switching time required for operation of the first decade counter. Operating current for the trigger is set by resistor R13, while R15 sets the bias of zener diode ZD1 in its zener region.

Input Sensitivity controls R3 and R6, by virtue of dc coupling, adjust the threshold of the Schmitt trigger circuit to insure that very small input signals can be measured with the counter.

Emitter follower transistor Q7 keeps the TTL (transistor-transistor-logic) in the counter circuit from loading the Schmitt trigger circuit.

1 MHz CLOCK AND SCALER

A 1 MHz crystal and gates A and D of IC21 are used to form a TTL – compatible clock. Capacitors C9 and C11 provide the proper capacitive load for the crystal. C11 is variable to allow for precise calibration of the oscillator. Resistors R28. R29, and R31 assure efficient starting of the clock oscillator. Gate B of IC21 provides buffering action between the oscillator and the first decade divider of the time base scaler.

The scaler consists of six decade dividers. The Range switch selects the output from the third or sixth divider for the reset pulse, and either the A output of IC18 or the Q output of IC24A for the input gating pulse. Therefore, the Range switch can provide either a 1-millisecond (MHz) or a 1-second (kHz) time base for the gating, reset, and memory circuits. The A output of IC20 provides the transfer pulse.

GATING, MEMORY, AND RESET

The gating, memory, and reset circuit controls the times that an input signal is gated into the counting circuits, the times that the accumulated information is passed from the counting circuits to the readout circuits, and the times that the counter circuits are reset to zero to begin a new counting cycle.

Figure 4-1 (fold-out from Page 42) shows the pulse relationships of the gating, memory, and reset circuit. Refer to this Figure as you read the following information.

When the Range switch is in the MHz position, the "gate open" signal is a 1-millisecond pulse that is obtained from the A output (pin 12) of IC18. The input signal enters the counters during the millisecond that the logic 1 of the gating signal is present on the J and K inputs of the first flip-flop of the first decade divider (pins 9 and 3 of IC25).

The reset pulse is derived by combining the inverted gate signal with the output of IC17 in IC23D. During the time that both the output of IC17 and the inverted gate signal from IC23C are high, a logic 1 at both inputs of NAND gate IC23D causes a logic 0 reset pulse to be applied to the first DCU (decade counting unit) and to IC24B, the overrange flip-flop. This reset pulse is inverted by Q8 to supply a logic 1 reset pulse to IC's 11 through 14. These reset pulses occur every two milliseconds, immediately prior to the gate opening.

The transfer signal is derived by combining the reset pulse (pin 11 of IC23D) with the inverted gate pulse in NAND gate IC23A. The resultant pulse is then inverted by IC21C.

A transfer pulse cannot occur during a reset pulse because IC23B is inhibited by a logic 0 on its pin 4 from IC21C. The transfer pulse can occur only when pin 4 is at a logic 1 and during a postive-going transition at the A output of IC20, which is differentiated by C12 and R36 and applied to IC23B as a positive spike. IC23B then has a logic 1 at each input and therefore a logic 0 output. The negative output spike is inverted by Q9 and the positive spike is applied as a transfer pulse to IC's 6 through 10, and IC's 22A and 22D.

Although the reset cycle occurs every two milliseconds, the differentiated A output of IC20 allows the transfer pulse to occur only every 200 milliseconds. Therefore, 100 count-reset cycles will occur for every memory update to prevent the appearance (due to the persistence of the human eye) of more than one lighted number in the last digit.

When the Range switch is in the kHz position, the "gate open" signal is a 1-second pulse that is obtained from the Q output (pin 12) of IC24A.

The reset pulse is derived in the same manner as with the Range switch in the MHz position, except that the basic signals are obtained from the D output (pin 11) of IC20 and the Q output of IC24A.

The transfer pulse is also derived in the same manner as with the Range switch in the MHz position, except that the gate reset cycle now occurs every two seconds and the transfer occurs every 200 milliseconds (unless inhibited by the presence of either a reset pulse or a gate-open pulse). Therefore, there are four transfer pulses for every gate reset cycle. These extra pulses, however, will have no effect on the readout since neither the "gate-open" nor reset can occur during their time duration. As a consequence, the same count is simply transferred four times.

FIRST DECADE COUNTER

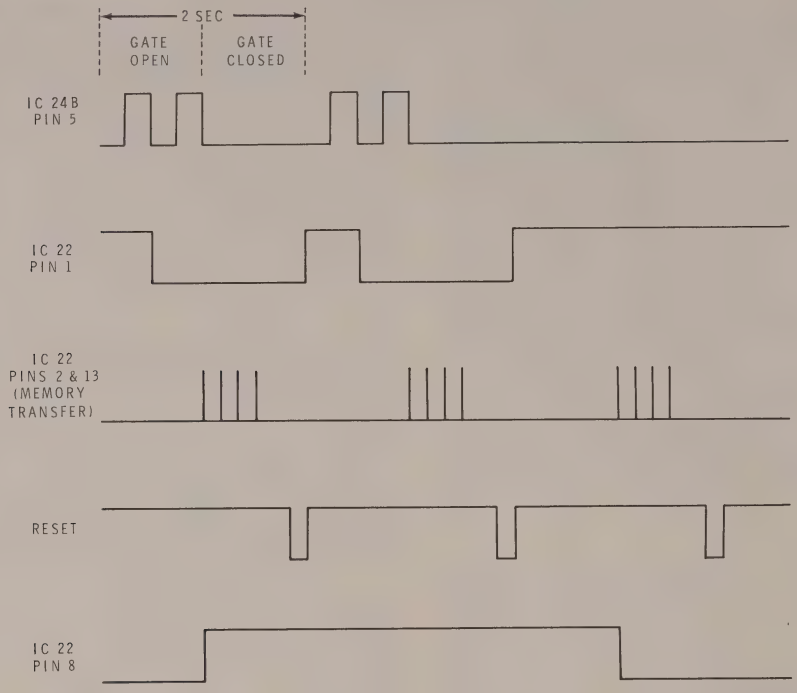
Figure 4-2 (fold-out from Page 42) shows the pulse relationships in the first decade counter (IC25, IC26A, IC26B, IC27). Refer to this Figure as you read the following information.

This circuit is connected as an asynchronous BCD counter, and the flip-flops are triggered by negative-going pulses. Flip-flop IC25 is toggled by the signal from the Schmitt trigger circuit. As IC25 is toggled on every input pulse when both the J and K inputs are at logic 1, the Q output (A) goes to a logic 1 on the 1st, 3rd, 5th, 7th, and 9th counts.

These pulses are then applied to the toggle input of IC26A. However, because of the feedback loop from $\overline{Q}$ of IC27 to the J input of IC26A, IC26A is inhibited on the tenth count. This results in the Q output of IC26A being a logic 1 for the 2nd, 3rd, 6th, and 7th counts. IC26B is toggled by the Q output of IC26A on the 4th and 8th counts. Therefore, the Q output of IC26B is a logic 1 for the 4th, 5th, 6th, and 7th counts.

Two feed-forward loops are incorporated around IC27, which is toggled by the Q output of IC25, to inhibit its toggling on any pulse except the 8th and the 10th count. This is accomplished by connecting the Q outputs of IC26A and IC26B to the J inputs of IC27. As a result, IC27 will toggle only when both of the Q outputs from IC26A and IC26B are at logic 1. This results in the Q output of IC27 being at logic 1 for the 8th and 9th counts only. On the 10th count, IC25 toggles to a logic 0 at its Q output as its J input is a logic 0. IC26A and IC26B will stay at logic 0 as they were not toggled. IC27 is forced to logic 0 because its J input is at logic 0.

Reset is accomplished by taking all clear inputs of the flip-flops to a logic 0. These logic levels are supplied by IC23D. Counting is started when the J and K inputs of IC25 are taken to logic 1, and inhibited when these same inputs are returned to a logic 0. These logic levels are supplied by the A output of IC18 or the Q output of IC24A, as determined by the position of the Range switch.



OVERRANGE DETECTOR PULSE

Figure 4-3

SECOND, THIRD, FOURTH, AND FIFTH DECADE COUNTERS

These counters are asynchronous BCD counters that require a single integrated circuit for each decade. The main difference between the operation of these counters and that of the first decade counter is that no gating is required. This is because none of the subsequent counters can operate unless the first counter is counting and produces a "spillover" or carry pulse. Reset is provided by Q8, and is initiated when the reset lines go to a logic 1 state.

The internal operation of these circuits are similar to that of the first decade counter.

OVERRANGE DETECTION

Figure 4-3 shows the pulse relationships of the overrange detector. Refer to this Figure and the schematic as you read the following information.

If the count passes from 99999 to 100,000, a pulse is produced at the D output (pin 11) of IC14. This spillover toggles IC24B, which is a standard J-K flip-flop. The K input of this IC is tied to logic 0 (ground), which causes the $\overline{Q}$ output to latch in a logic 0 condition whenever the CP input is toggled. The $\overline{Q}$ output remains in this condition until a logic 0 is applied to the C (clear) input.

IC22 is a quad, two-input NAND gate package used as an inverting data latch. The logic level at pin 1 of IC22 will be inverted and transferred to pin 8 (the Q output) when pin 2 and pin 13 are both at logic 1. A logic 0 at these inputs will inhibit transfer. The output of the latch is connected to the base of NPN transistor Q10. Therefore the overrange lamp will light only when there is a logic 1 output from pin 8 of IC22. This results in the visual display (OVER) that indicates a spillover from IC14.

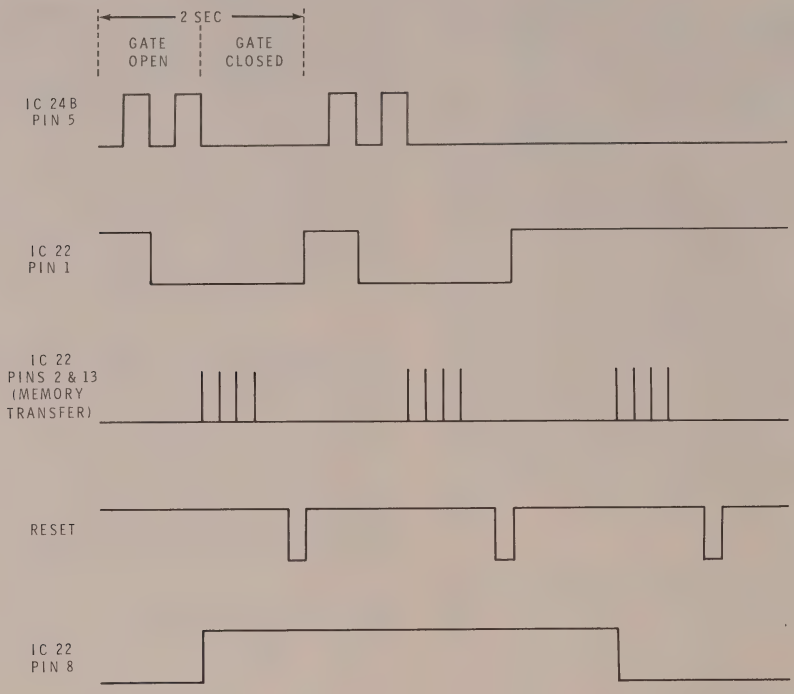
READ

The fo
connect
IC10.)
only wh
transfer
outputs
may cha

The inf
decodec
IC5. Th
cold-cat
how thi
each nu
BCD co
display
can occ
should
the false

POWE

The pov
one unr



OVERRANGE DETECTOR PULSE

Figure 4-3

SECOND, THIRD, FOURTH, AND FIFTH DECADE COUNTERS

These counters are asynchronous BCD counters that require a single integrated circuit for each decade. The main difference between the operation of these counters and that of the first decade counter is that no gating is required. This is because none of the subsequent counters can operate unless the first counter is counting and produces a "spillover" or carry pulse. Reset is provided by Q8, and is initiated when the reset lines go to a logic 1 state.

The internal operation of these circuits are similar to that of the first decade counter.

OVERRANGE DETECTION

Figure 4-3 shows the pulse relationships of the overrange detector. Refer to this Figure and the schematic as you read the following information.

If the count passes from 99999 to 100,000, a pulse is produced at the D output (pin 11) of IC14. This spillover toggles IC24B, which is a standard J-K flip-flop. The K input of this IC is tied to logic 0 (ground), which causes the $\overline{Q}$ output to latch in a logic 0 condition whenever the CP input is toggled. The $\overline{Q}$ output remains in this condition until a logic 0 is applied to the C (clear) input.

IC22 is a quad, two-input NAND gate package used as an inverting data latch. The logic level at pin 1 of IC22 will be inverted and transferred to pin 8 (the Q output) when pin 2 and pin 13 are both at logic 1. A logic 0 at these inputs will inhibit transfer. The output of the latch is connected to the base of NPN transistor Q10. Therefore the overrange lamp will light only when there is a logic 1 output from pin 8 of IC22. This results in the visual display (OVER) that indicates a spillover from IC14.

READOUT AND MEMORY LATCHES

The four BCD outputs from each decade counter are connected to a memory latch (IC6, IC7, IC8, IC9, and IC10.) These latches transfer the signals to their outputs only when the transfer line goes to a logic 1. When the transfer line returns to logic 0, the information at the latch outputs is retained even though the logic level at the inputs may change.

The information at the outputs of the memory latches is decoded into a ten-bit code by decoder/drivers IC1 through IC5. This information is then applied to the ten-numeral cold-cathode display tubes. The table of Figure 4-4 shows how this input signal is decoded. A logic 0 is required by each number for turn-on. If a code other than BCD (or a BCD count which exceeds 9) is received by the driver, the display will not register valid information. This condition can occur only when the Counter is first turned on. If this should occur, the next reset and transfer pulse will remove the false codes and the subsequent displays will be valid.

TRUTH TABLE

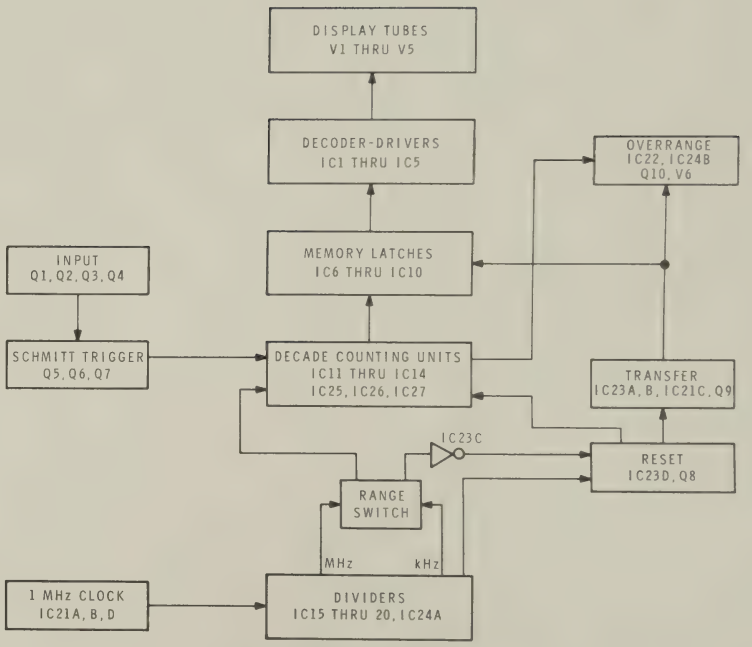
INPUT				LOW OUTPUT ON *
D	C	B	A	
L	L	L	L	0
L	L	L	H	1
L	L	H	L	2
L	L	H	H	3
L	H	L	L	4
L	H	L	H	5
L	H	H	L	6
L	H	H	H	7
H	L	L	L	8
H	L	L	H	9

H = high level, L = low level
*All other outputs are high (LOGIC 1).

Figure 4-4

POWER SUPPLY

The power transformer is used to operate two regulated and one unregulated dc power supplies. One of the regulated supplies provides +5 volts at 700 milliamperes, while the other one provides +15.5 volts at 70 milliamperes. The third, unregulated (half-wave) supply provides the high voltage (HV) necessary for the front panel readouts.

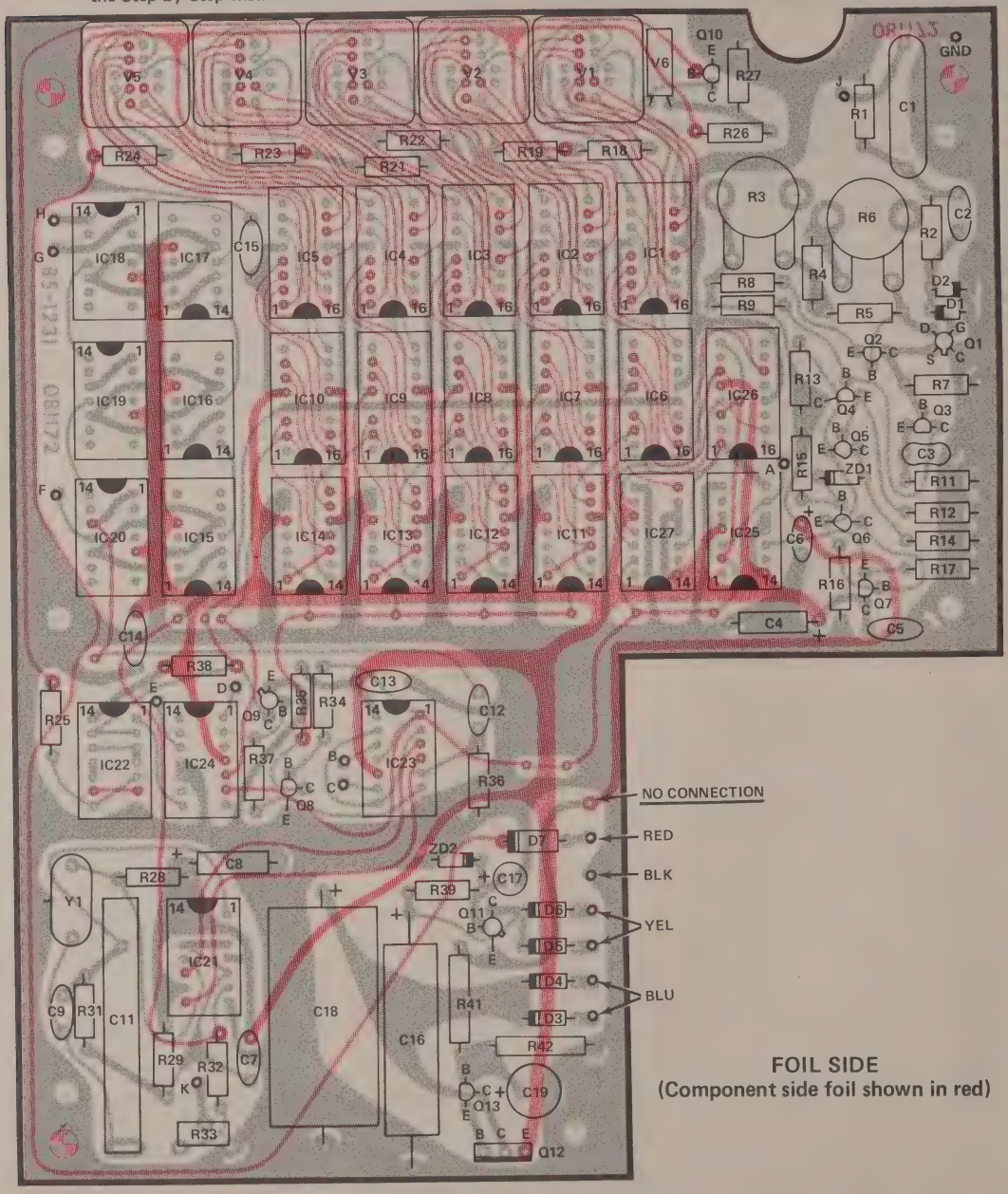


BLOCK DIAGRAM

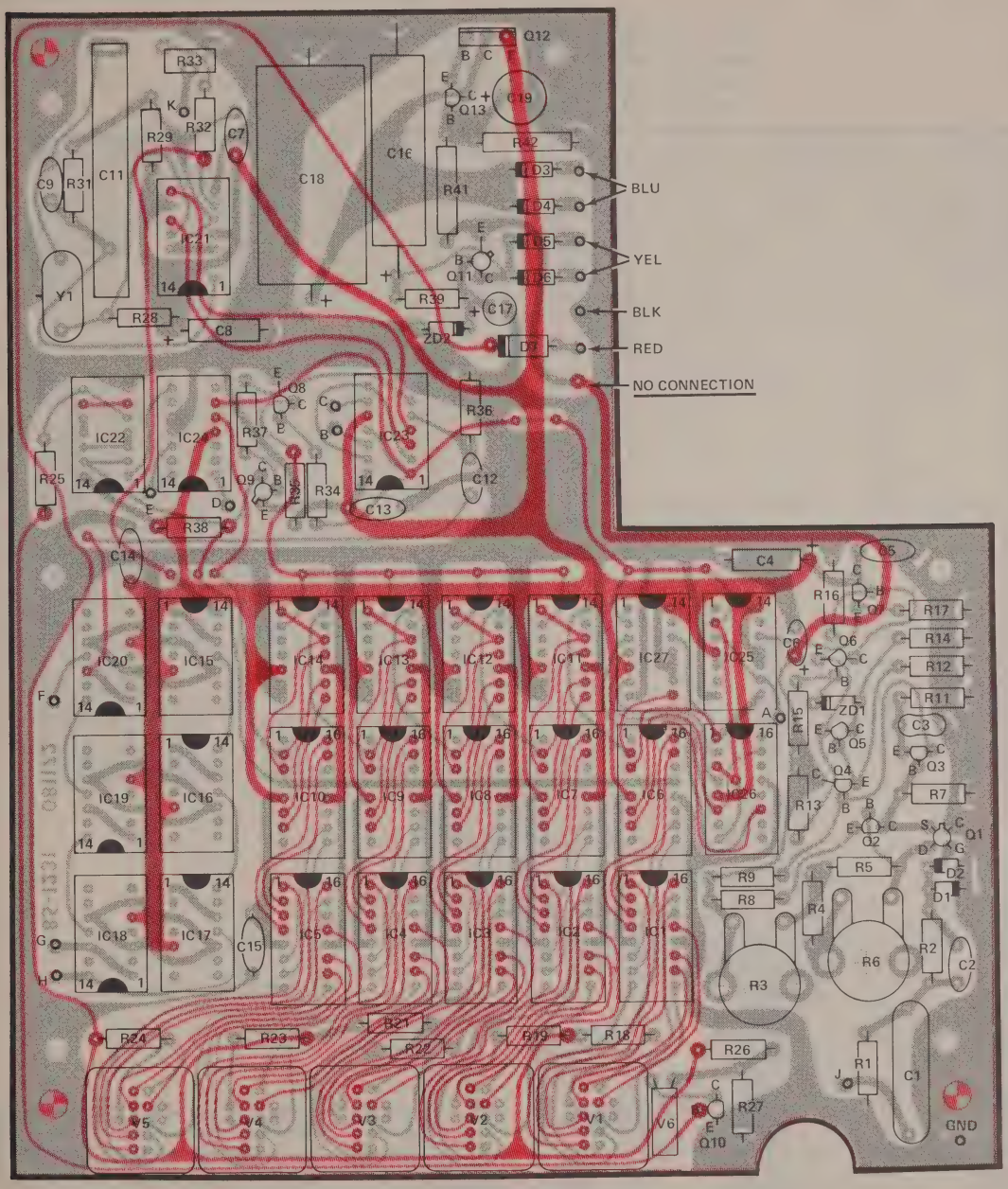
CIRCUIT BOARD X-RAY VIEWS

NOTE: To determine the value (22 Ω, 4 μF, etc.) of one of these parts, you may proceed in either of the following ways.

1. Refer to the place where the part is installed in the Step-by-Step Instructions.
2. Note the identification number of the part (R-number, C-number, etc.). Then locate the same identification number next to the part on the Schematic. The value, or "Description," of most parts will be near this number.



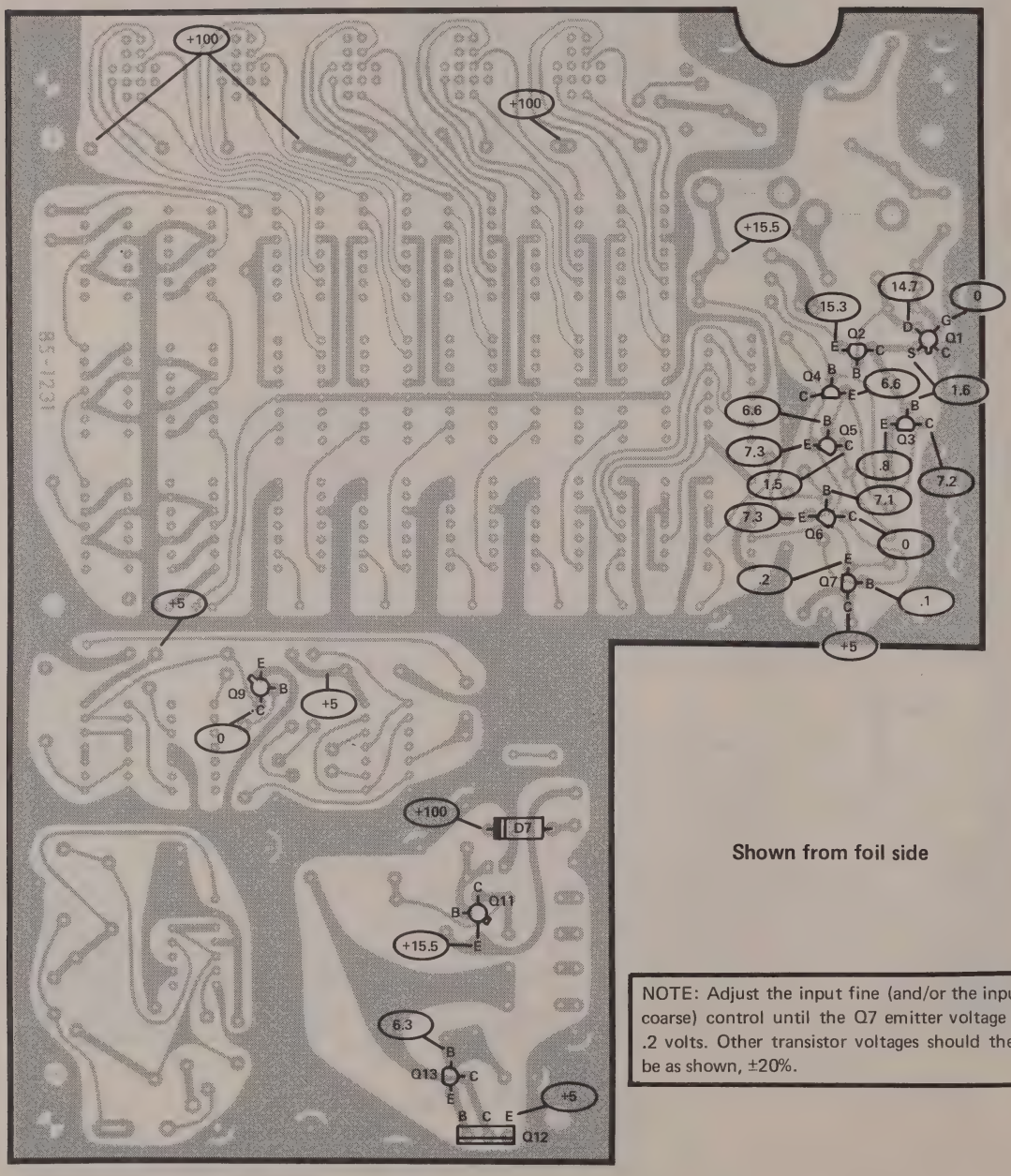
FOIL SIDE
(Component side foil shown in red)



COMPONENT SIDE
(Component side foil shown in red)

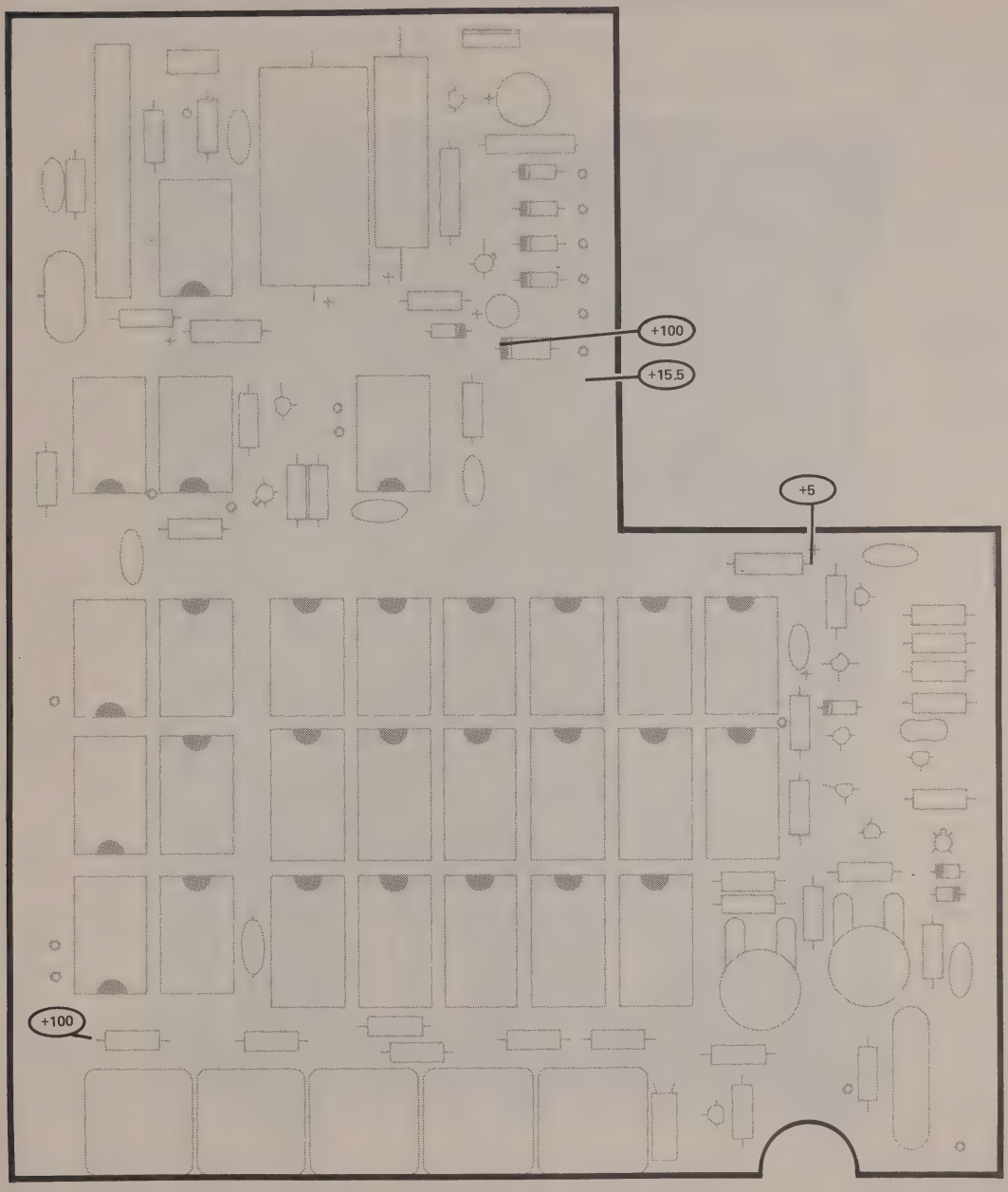
CIRCUIT BOARD VOLTAGE CHARTS

NOTE: Indicated values are dc voltages taken with a high impedance input voltmeter from the point shown to chassis ground with no input signal to the Counter. Voltages may vary ±20%.



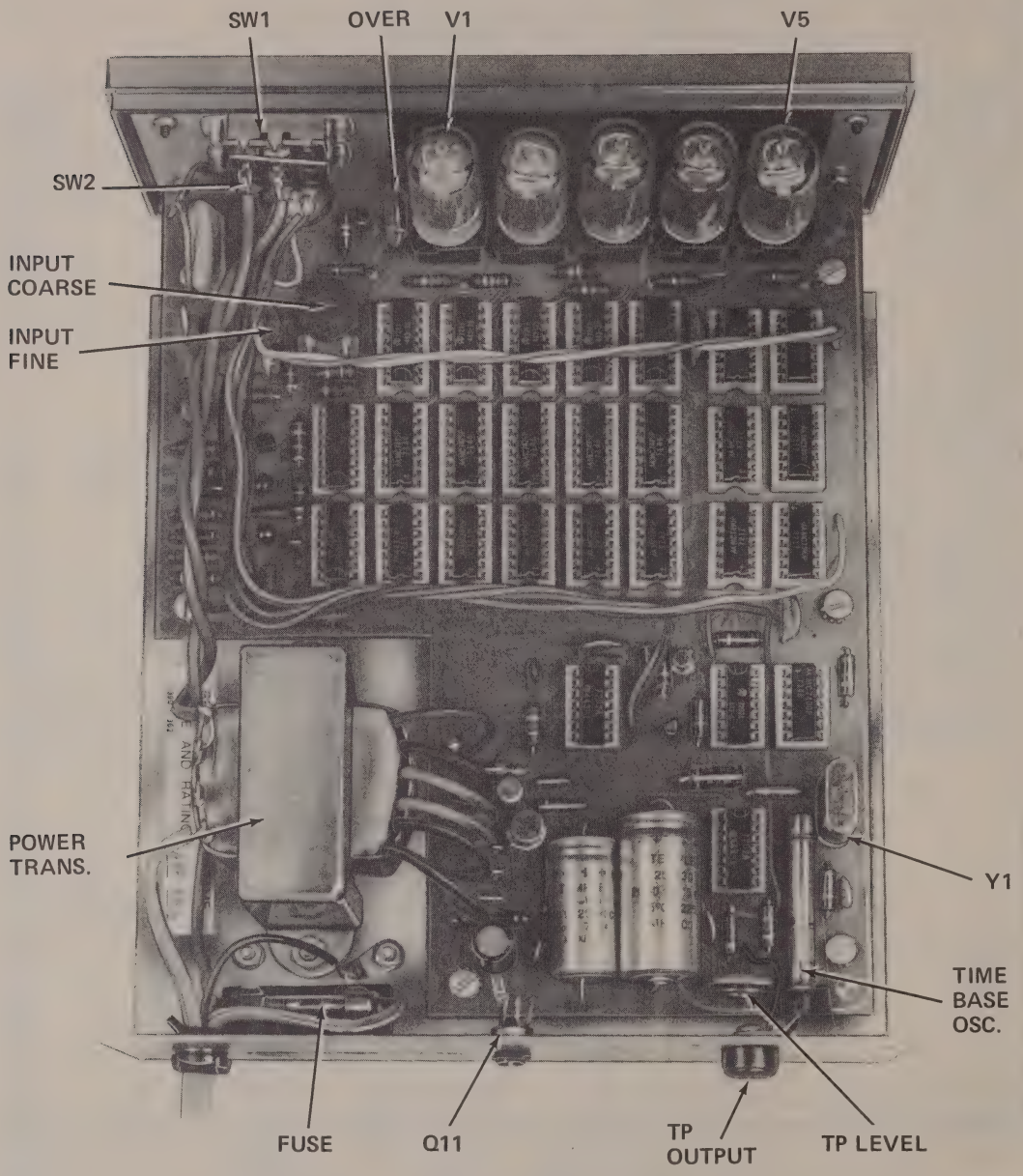
Shown from foil side

NOTE: Adjust the input fine (and/or the input coarse) control until the Q7 emitter voltage is .2 volts. Other transistor voltages should then be as shown, ±20%.

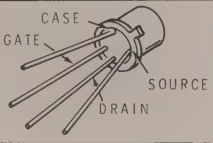
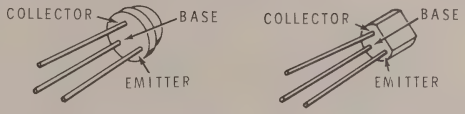
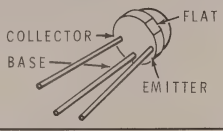
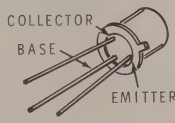
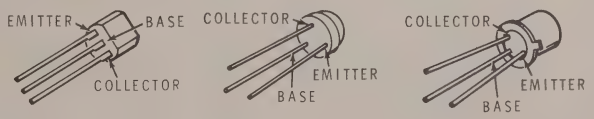
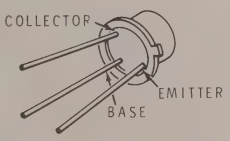


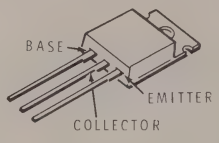
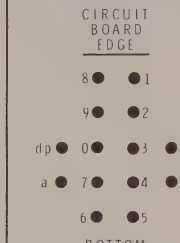
Shown from component side

CHASSIS PHOTOGRAPH



TUBE-TRANSISTOR IDENTIFICATION CHART

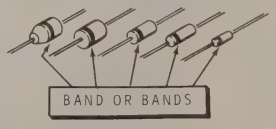
COMPONENT	HEATH PART NO.	REPLACEMENT TYPE & RATING	BASE VIEW
Q1	417-251	SFC2912	
Q2	417-235	2N4121	
Q3, Q7	417-125	2N3563	
Q4	417-134	MPS6520	
Q5, Q6	417-260	2N4258A	
Q8, Q13	417-118	2N3393	
Q9	417-154	2N2369	
Q10	417-173	ETS083	
Q11	417-269	SGC5282	

COMPONENT	HEATH PART NO.	REPLACEMENT TYPE & RATING	BASE VIEW
Q12	417-175	2N5294	
V6	412-15	NE2H	
V1-V5	411-284	AMPEREX ZM-1000	

PIN	CONNECTION
1	NUMERAL 1
2	NUMERAL 2
3	NUMERAL 3
4	NUMERAL 4
5	NUMERAL 5
6	NUMERAL 6
7	NUMERAL 7
8	NUMERAL 8
9	NUMERAL 9
0	NUMERAL 0
a	ANODE
dp	DECIMAL POINT

DIODE IDENTIFICATION CHART

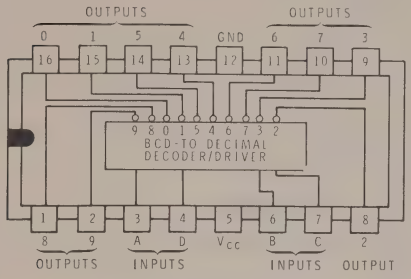
COMPONENT	HEATH PART NO.	MAY BE REPLACED WITH	IDENTIFICATION
D1, D2	56-56	1N4149	HEATH PART NUMBERS ARE STAMPED ON MOST DIODES.
D3, D4, D5, D6	56-65	1N4002	NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.
D7	57-27	1N2071	
ZD2	56-36	VR16.1G, 12mA 16.1 VOLT	
ZD1	56-63	MZ500-10, 5.6VOLT, 1mA ZENER	



INTEGRATED CIRCUIT BASE DIAGRAMS

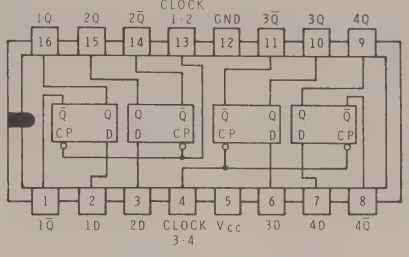
(All diagrams shown from top)

IC1
IC2
IC3
IC4
IC5


OUTPUTS
OUTPUTS
0 1 5 4 GND 6 7 3
16 15 14 13 12 11 10 9
9 8 0 1 5 4 6 7 3 2
BCD-TO DECIMAL
DECODER/DRIVER
1 2 3 4 5 6 7 8
8 9 A D Vcc B C 2
OUTPUTS INPUTS INPUTS OUTPUT

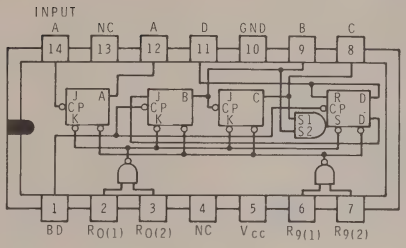
SN7441B BCD—TO—DECIMAL DECODER/DRIVER
#443—35

IC6
IC7
IC8
IC9
IC10



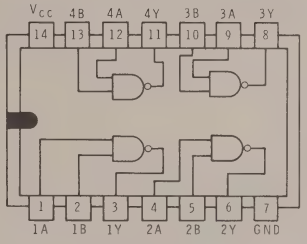
SN7475N 4—BIT BISTABLE LATCH
#443—13

IC11
IC12
IC13
IC14
IC15
IC16
IC17
IC18
IC19
IC20



SN7490N DECADE COUNTER
#443—7

IC21
IC22
IC23

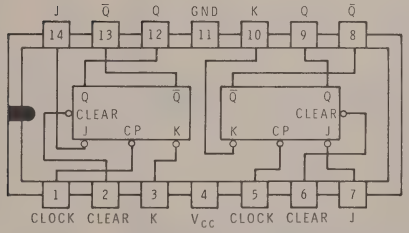


TRUTH TABLE
(EACH GATE)

INPUTS		OUTPUT
A	B	
0	0	1
0	1	1
1	0	1
1	1	0

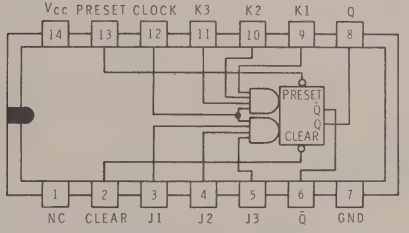
SN7400N QUADRUPLE 2—INPUT POSITIVE NAND GATE
#443—1

IC24



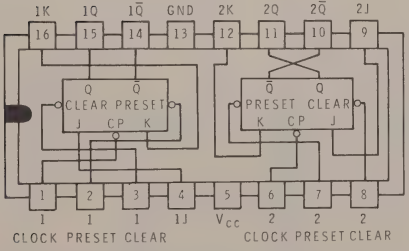
SN7473N DUAL J—K MASTER SLAVE FLIP—FLOP
#443—5

IC25



SN74H102N J—K EDGE TRIGGERED FLIP—FLOP
#443—43

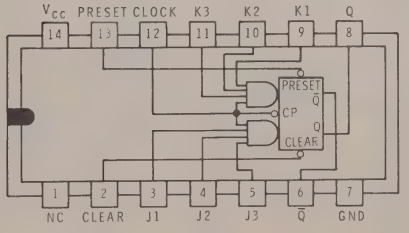
IC26


1K 1Q 1Q̄ GND 2K 2Q 2Q̄ 2J
16 15 14 13 12 11 10 9
Q Q
CLEAR PRESET
J CP K
Q̄ Q
PRESET CLEAR
K CP J
1 2 3 4 5 6 7 8
1 1 1 1J Vcc 2 2 2
CLOCK PRESET CLEAR CLOCK PRESET CLEAR

LOW INPUT TO PRESET SETS Q TO LOGICAL 1.
LOW INPUT TO CLEAR SETS Q TO LOGICAL 0.
CLEAR AND PRESET ARE INDEPENDENT OF CLOCK.

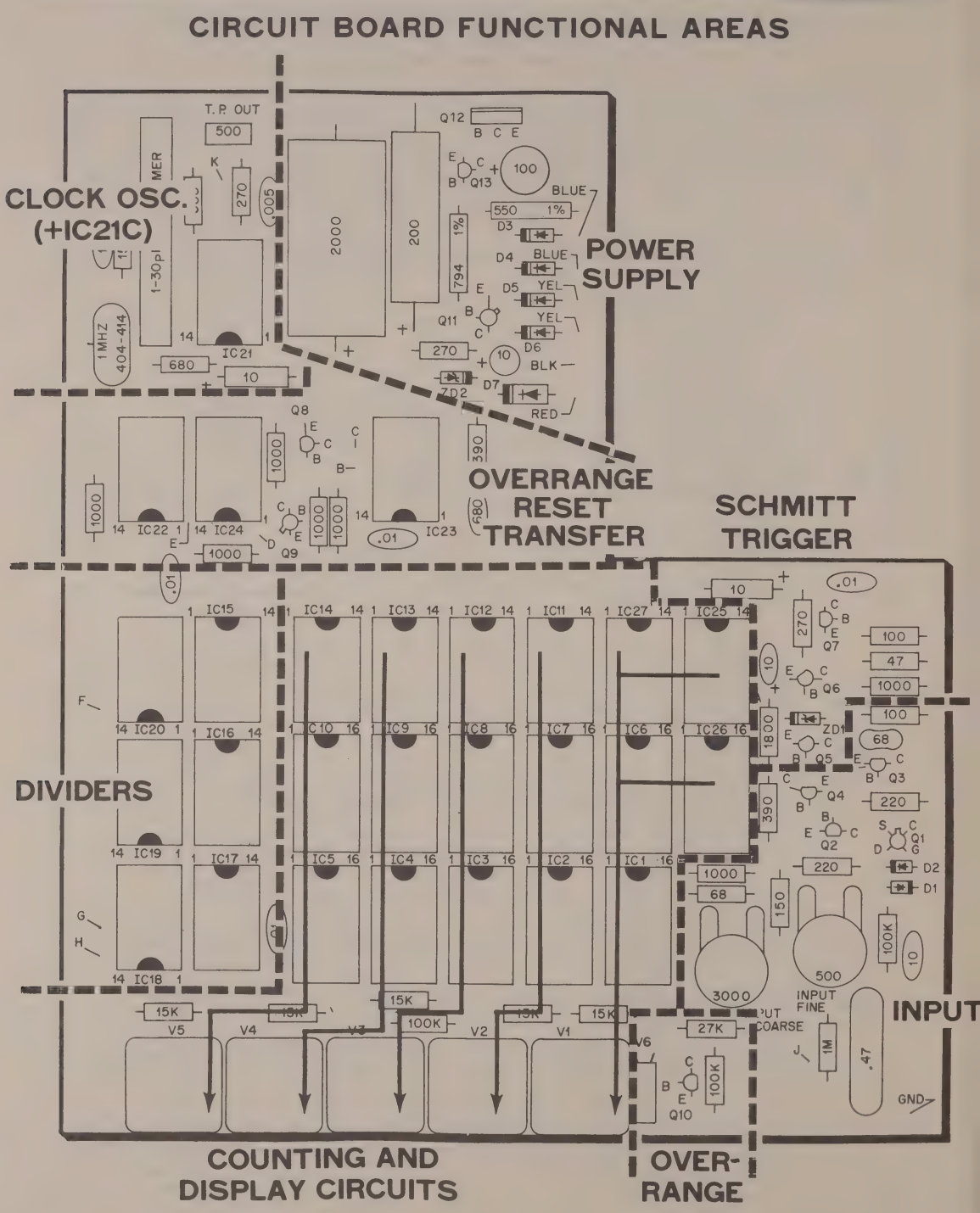
SN7476N DUAL J—K MASTER SLAVE FLIP—FLOP
#443—16

IC27

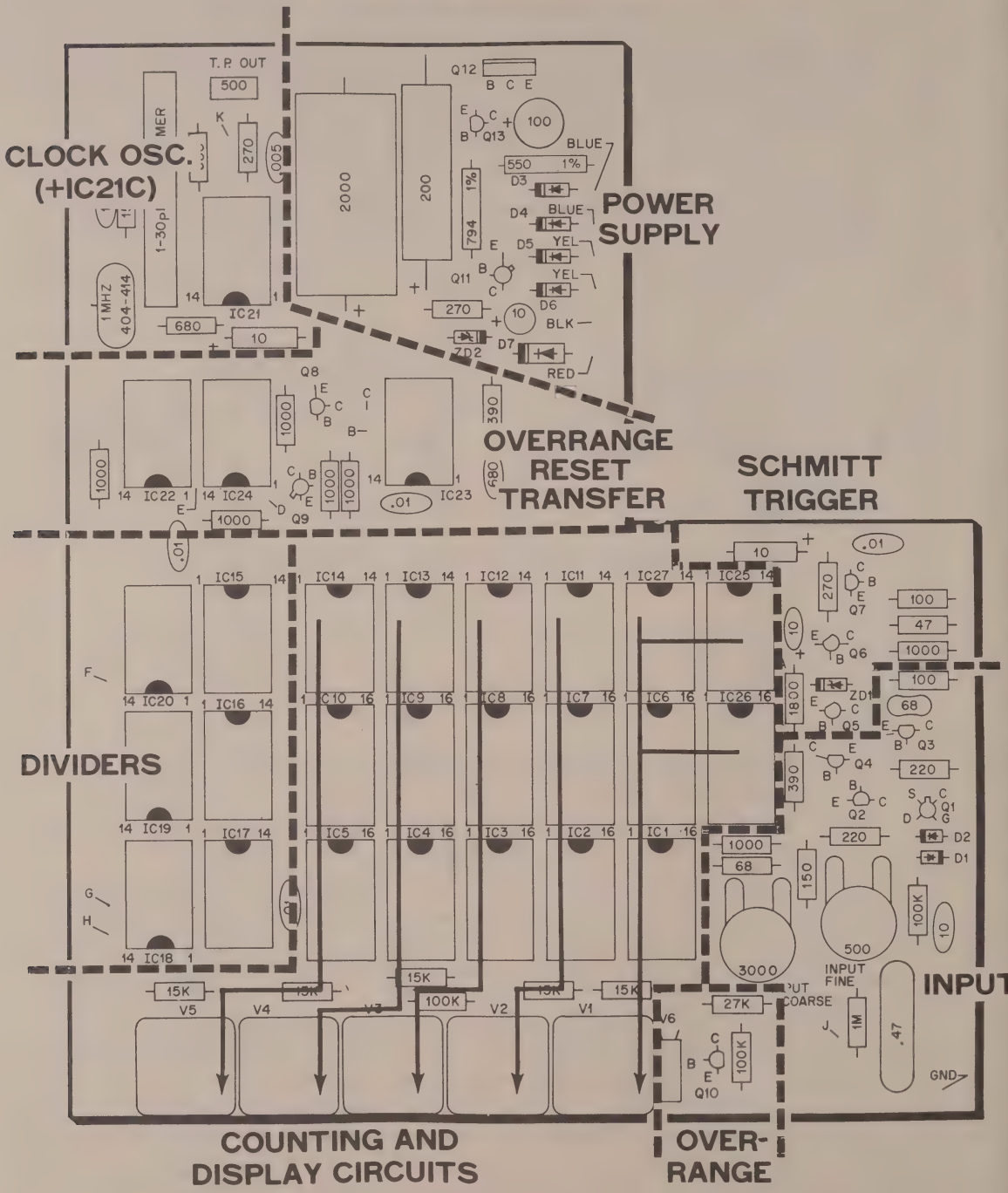


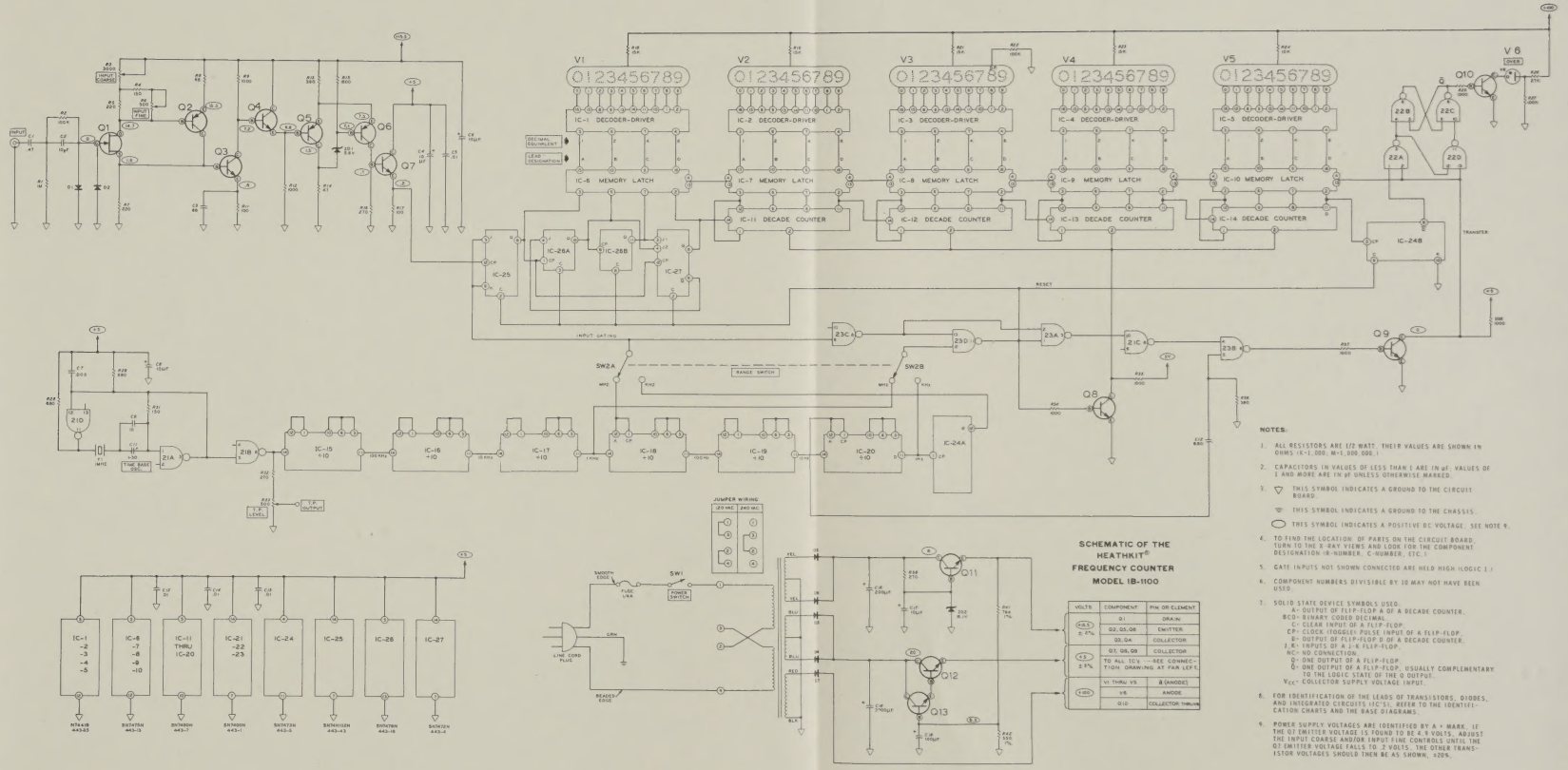
LOW INPUT TO PRESET SETS Q TO LOGICAL 1.
LOW INPUT TO CLEAR SETS Q TO LOGICAL 0.
PRESET AND CLEAR ARE INDEPENDENT OF CLOCK.

SN7472N J—K MASTER SLAVE FLIP—FLOP
#443—4


CIRCUIT BOARD FUNCTIONAL AREAS
CLOCK OSC. (+IC21C)
POWER SUPPLY
OVERRANGE RESET TRANSFER
SCHMITT TRIGGER
DIVIDERS
INPUT
COUNTING AND DISPLAY CIRCUITS
OVER-RANGE
T. P. OUT
500
MER
1-30pl
1 MHZ
404-414
IC21
680
10
270
.005
2000
200
1%
794
550 1%
BLUE
D3
D4
D5
YEL
D6
BLK
D7
RED
ZD2
Q11
Q12
B C E
Q13
100
IC22
IC24
IC23
1000
.01
Q8
Q9
390
IC15
IC14
IC13
IC12
IC11
IC27
IC25
IC20
IC16
IC10
IC9
IC8
IC7
IC6
IC26
IC19
IC17
IC5
IC4
IC3
IC2
IC1
IC18
Q7
Q6
ZD1
Q5
Q3
Q4
Q2
Q1
47
68
220
1800
150
100K
3000
500
INPUT FINE
COARSE
1M
.47
GND
D2
D1
15K
100K
27K
V1
V2
V3
V4
V5
V6
Q10

CIRCUIT BOARD FUNCTIONAL AREAS





SCHEMATIC OF THE HEATHKIT® FREQUENCY COUNTER MODEL IB-1100

VOLTS	COMPONENT	PIN OR ELEMENT
+16.5 ± 2%	Q1	DRAIN
	Q2, Q5, Q6	EMITTER
	Q3, Q4	COLLECTOR
+5 ± 5%	Q7, Q8, Q9	COLLECTOR
	TO ALL IC's — SEE CONNECTION DRAWING AT FAR LEFT.	
	V1 THRU V5	8 (ANODE)
+165	V6	ANODE
	Q10	COLLECTOR THRU R

NOTES:

1. ALL RESISTORS ARE 1/2 WATT. THEIR VALUES ARE SHOWN IN OHMS (R-1,000, M-1,000,000.)
2. CAPACITORS IN VALUES OF LESS THAN 1 ARE IN µf. VALUES OF 1 AND MORE ARE IN pf UNLESS OTHERWISE MARKED.
3. ▽ THIS SYMBOL INDICATES A GROUND TO THE CIRCUIT BOARD.
   ⏚ THIS SYMBOL INDICATES A GROUND TO THE CHASSIS.
   ⬭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE. SEE NOTE 9.
4. TO FIND THE LOCATION OF PARTS ON THE CIRCUIT BOARD, TURN TO THE X-RAY VIEWS AND LOOK FOR THE COMPONENT DESIGNATION (R-NUMBER, C-NUMBER, ETC.)
5. GATE INPUTS NOT SHOWN CONNECTED ARE HELD HIGH (LOGIC 1.)
6. COMPONENT NUMBERS DIVISIBLE BY 10 MAY NOT HAVE BEEN USED.
7. SOLID STATE DEVICE SYMBOLS USED:
   A- OUTPUT OF FLIP-FLOP A OF A DECADE COUNTER.
   BCD- BINARY CODED DECIMAL.
   C- CLEAR INPUT OF A FLIP-FLOP.
   CP- CLOCK (TOGGLE) PULSE INPUT OF A FLIP-FLOP.
   D- OUTPUT OF FLIP-FLOP D OF A DECADE COUNTER.
   J,K- INPUTS OF A J-K FLIP-FLOP.
   NC- NO CONNECTION.
   Q- ONE OUTPUT OF A FLIP-FLOP.
   $\overline{Q}$- ONE OUTPUT OF A FLIP-FLOP, USUALLY COMPLEMENTARY TO THE LOGIC STATE OF THE Q OUTPUT.
   V_{CC}+ COLLECTOR SUPPLY VOLTAGE INPUT.
8. FOR IDENTIFICATION OF THE LEADS OF TRANSISTORS, DIODES, AND INTEGRATED CIRCUITS (IC'S), REFER TO THE IDENTIFICATION CHARTS AND THE BASE DIAGRAMS.
9. POWER SUPPLY VOLTAGES ARE IDENTIFIED BY A + MARK. IF THE Q7 EMITTER VOLTAGE IS FOUND TO BE 4.9 VOLTS, ADJUST THE INPUT COARSE AND/OR INPUT FINE CONTROLS UNTIL THE Q7 EMITTER VOLTAGE FALLS TO 2 VOLTS. THE OTHER TRANSISTOR VOLTAGES SHOULD THEN BE AS SHOWN, ±20%.

CUSTOMER SERVICE

REPLACEMENT PARTS

If you need a replacement part, please fill in the Parts Order Form that is furnished and mail it to the Heath Company. Or, if you write a letter, include the:

- **Part number** and **description** as shown in the **Parts List.**
- Model number and Series number from the blue and white label.
- Date of purchase.
- Nature of the defect.

Please do not return parts to the factory unless they are requested. Parts that are damaged through carelessness or misuse by the kit builder will not be replaced without cost, and will not be considered in warranty.

Parts are also available at the Heathkit Electronic Centers listed in your catalog. Be sure to provide the Heath part number. Bring in the original part when you request a warranty replacement from a Heathkit Electronic Center.

NOTE: Replacement parts are maintained specifically to repair Heathkit products. Parts sales for other reasons will be declined.

TECHNICAL CONSULTATION

Need help with your kit? . . . . Self-Service? . . . . Construction? . . . . Operation? . . . . Call or write for assistance. You'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek. . .please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit C.O.D. for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH

Schlumberger

HEATH COMPANY • BENTON HARBOR, MICHIGAN

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

LITHO IN U.S.A.